

Armaments for the Army of the Future (**Army XXI Through Army After Next**)

An International Symposium & Exhibition

Proceedings

June 22-24, 1998

Parsippany Hilton Hotel Parsippany , NJ

Event #861

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- "US Army Medium Caliber S&T Business Area," by Mr. Michael J. Madden, TACOM-ARDEC.
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- "Mortars for Mounted Maneuver: Army XXI," by Mr. Peter Burke, Office of the PM for Mortars, TACOM.

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- "Land Warrior," by LTC W. E. "Bud" Irish, PM Small Arms, TACOM.
- "Objective Family of Small Arms," by Mr. Vernon Shisler, SM, TACOM.
- "The U.S. Department of Defense Joint Non-Lethal Weapons Program: A View to the Future," by Col. Andrew F. Mazzara, USMC, Director, Joint Non-Lethal Weapons Program.

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- "Field Artillery Materiel Requirements, 2010," by Mr. Ed Liles.
- "PM SADARM Programs," by COL Bernard Ellis, PM for Sense and Destroy Armor.
- "M109A6 155mm Self Propelled Howitzer Digitization Initiative," by Mr. Chuck Jacob, PM Paladin/FAASV, TACOM.
- "Horizontal Technology Integration for Indirect Fire Weapons Platforms," by Mr. Victor J. Galgano, TACOM-ARDEC and Mr. Xavier Minervini, AlliedSignal, Inc.
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"The Lightweight 155mm Howitzer Program," by Col. Steve C. Ward, USMC, Joint PM, Lightweight 155.

"Crusader Development: A Simulation Based Approach," by COL William B. Sheaves III, PM for Crusader and Mr. David Wallstad, PM Crusader, United Defense.

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"Hornet Wide Area Munition: An Essential Building Block for Achieving Unmanned Terrain Domination in Army XXI and Beyond!," by Mr. James J. Stamboni, Textron Systems Corp.

"Intelligent Combat Outpost (ICO) 'Raptor'," by Mr. Richard Q. Wagner, Fire Support Armaments Center (FSAC), TACOM-ARDEC.

Wednesday, June 24, 1998

"Advanced Vehicle Development," by Mr. Jerry L. Chapin, Director, TACOM-ARDEC.

"Army Logistical Support 2025," by MG Charles C. Cannon, Assistant Deputy Chief of Staff for Logistics, US Army.

"Industry Projections for Force XXI/AAN or Will We Still Be There?," by Dr. Stephen L. Gurba, President & CEO, Bulova Technologies.

"Canada's Efforts to Determine the Future Army," by LCOL Rusty Bassarab, Canadian Field Liaison Officer, AMC.

Session I

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"Future Combat Systems," by Mr. Larry D. Johnson, FCS Science & Technology Dir., ARL.

"The UK Electric Gun Programme in 1998," by Mr. David C. Haugh and Mr. M A Firth, Technology Leader, Electromagnetic Gun Defense Evaluation and Research Agency.

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"Soldier Load," by Mr. Robert O'Brien, Natick RDEC, USASSC.

"Advanced Kinetics: Small Arms Needs and Concepts for AAN and Beyond," by Mr. Donald J. Butz and Mr. Robert I. Widder, Battelle.

Session III

"Technology for Army After Next Fires," by Mr. John M. Miller and Mr. Walter F. Morrison, US Army Research Lab.

"Digitized Architecture," by Dr. George Vinansky, Jr., TACOM-ARDEC.

"Fire Control for the Army After Next," by Mr. Charles Seitz, TACOM-ARDEC.

"QuickLook: A Howitzer Launched Targeting Systems for the Brigade," by Mr. Robert Werko, FSAC.

"Micro Electro Mechanical Systems (MEMS) Applications in Weapon Surety and Inertial Sensing," by Mr. J.J. Allen, PE, Sandia National Labs.

"GPS for Munitions," by Mr. Byran Wesner, Rockwell-Collins Avionics.

"GPS Auto Registration," by Mr. Gary Schlieckert, Alliant Techsystems, Inc.

"GPS-Counter Measures/Counter Counter Measures Techniques," by Mr. Andrew Ladas, Army Research Lab.

"DeadEye...A Remote Controlled Stabilized Gun Mount First Burst on Target!," by Mr. Edward Finkbeiner, General Dynamics

"Fire Support: Army XXI + & AAN Stabilized Secondary Armaments," by Mr. Dave Thibodeau, Kollmorgen Corporation.

Session IV

"Area Denial Methodologies Robotics for Munitions," by Mr. A. Keith Miller and Mr. William D. Morse, Sandia National Laboratories.

"Autonomous Aerial Delivery Vehicle (AADV) for the Precision Delivery of Sensors and Munitions," by Dr. Robert J. Correia, Textron Systems and Mr. Roger Allen, SSE Inc.

"Low Cost Sensor Technology for Future Targeting Systems," by Mr. John S. Eicke, Army Research Lab.

"Remote Personnel Detection and Imaging," by Mr. John H. McQuiddy and Mr. Russel Thomas, MCQ Associates, Inc.

"Unmanned Aerial Vehicles (UAVs): Airborne Area Denial System (AADS)," by Dr. Gene H. McCall and Mr. Waits L. May, Los Alamos National Lab.

MG Roy E. Beauchaithip

IDIAY/Armaments for Army Afrer Next

Committed to Excellence





OUTLINE



Future Warfare

Army XXI

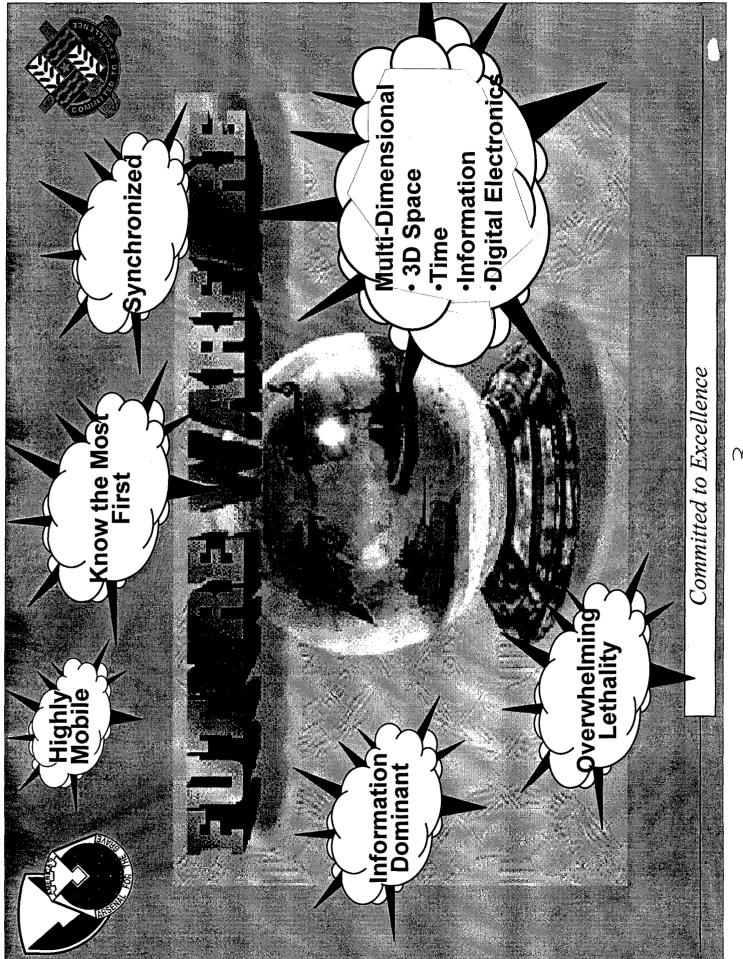
Army After Next (AAN)

New Challenges for Achieving Future Warfare

Legacy System Improvements for Army XXI R&D Efforts for Army of the Future

Summary

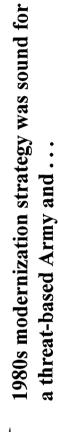
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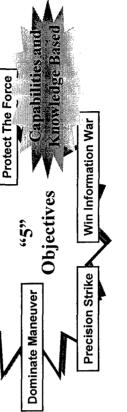
Modernization Yesterday-Today-Tomorrow

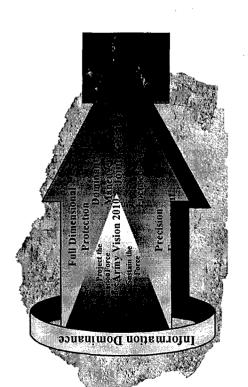




Systems

Project & Sustain Current 1990s strategy has strived to keep modernization objectives in balance,...





New modernization strategy synchronizes Army's operational requirements with an investment strategy that enables a full-spectrum dominance force.

Foundation to Spearhead the Army to Meet Future Demands

Committed to Excellence

J



Changing To Meet The Nation's Needs **Today & Tomorrow**



Army XXI

Maintain Overmatch Establish Info Dominance

- Training
- Doctrine
- Force Design
- Information Age Technology



A M

while focusing

Force XXI

Fielding

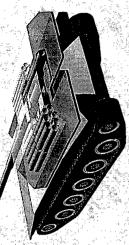
Army After

Next

on the

Army After Next Knowledge & Speed Full-Spectrum Dominance Revolutionary

- Change...
- Greater Lethality
 Greater Strategic / Operational Mobility
- Logistically Unencumbered
 - Greater Versatility
- Narrow gap between
 Heavy / Light Capability
 Lethal / Non-lethal
 - Expansibility



to Major Competitors

To achieve continuous full-spectrum dominance

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Firepower

Mobility





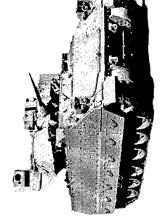
Lethality

Survivability



Legacy System Improvements for Army XX





A3 Improvements

Over A20DS

Matches Abrams

OPTEMPO



M109A6 PALADIN HOWITZER

- Provides On-Board Autonomous Fire Control Provides On-Board Autonomous Navigation **Ballistic Processing**
- Capable of both Voice and Digital Communications Commercial Based Processor (Pentium 133 MHz) First Fire Support Weapon System to Utilize a and Operating System (Windows NT 4.0)



Longbow Upgrades

 Gun system improvements Weapon System Program via Multi-Role Aviation

Improved Command and

Control (C4I)

M1A2 SEP Program

Reduced Fratricide

Lethality

Target Acquisition

Target Handoff

Hydra 70 and Advanced Rocket Warhead Improvements

Improved Sustainability with

Improved See, Hit, Kill

Electronic Cooling System

GPS/INS and Digital Maps

Improved Mobility with

- Conventional and Non-Lethal
- Advanced Missile Warhead Concepts



Comanche

- Improvements via Multi-Role Aviation Weapon System Program Gun system
 - **On-going Turreted Gun** System Support
- Hydra 70 and Advanced - Conventional and **Rocket Warhead Non-Lethal** Improvements
 - Warhead Concepts Advanced Missile

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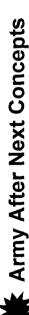


R&D Efforts for Army of the Future



Forture Scout and Cavalry system (FSCS)

Bridge to Army After Next



Future Infantry Vehicle (FIV)

Future Combat System (FCS)

Maneuver **Dominate**



·Crusader

•OICW

LW 155 Howitzer

Advanced Precision Munitions

Advanced Lethal Mechanisms

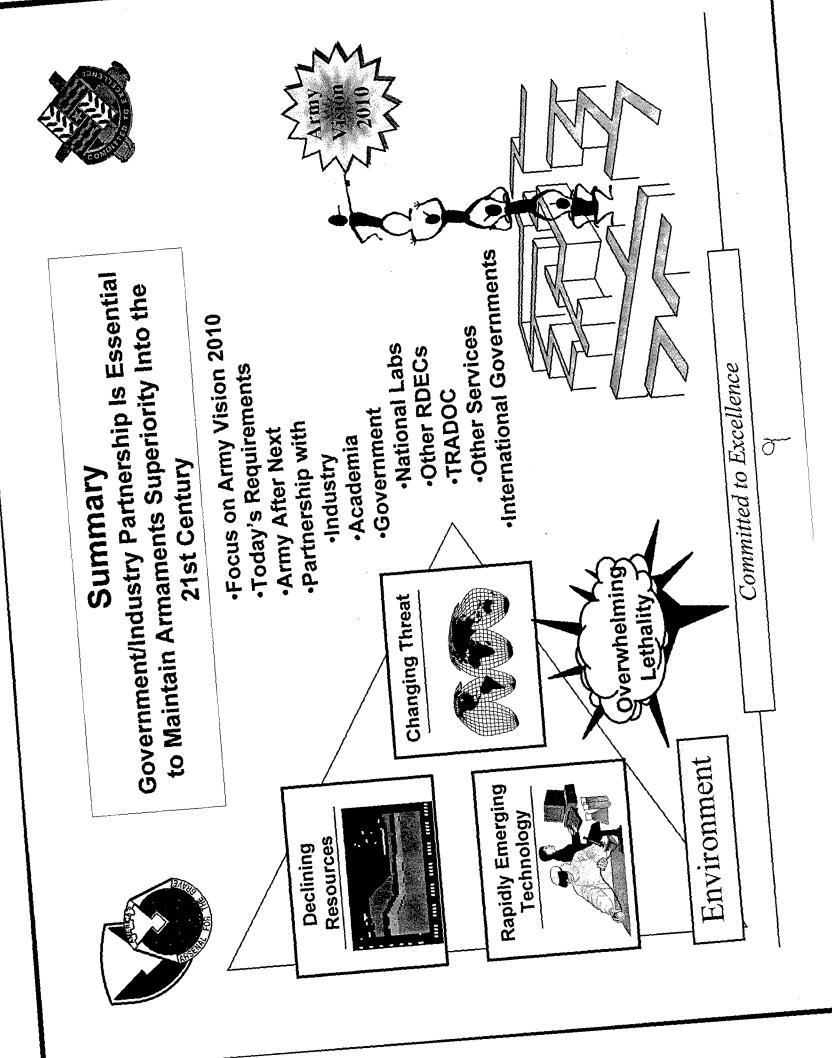
DEW/Tunable Lethality

•PGMM

WAM

<u>O</u>verwhelming ethality

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Presented by:

John S. Caldwell

Deputy Chief of Staff for Research, Development and Acquisition

Army Materiel Command



For the Armaments for the Army of the Future Symposium, NDIA

23 June 1998

४ Responsive AMC - Relevant,

Outline...

- Army Vision
- ✓ Army Science & Technology (S&T)
- ✓ AMC/TRADOC Partnership
- ✓ AMC and Force XXI
- ✓ AAN and the S&T Investment Strategy
- ✓ AMC and AAN
- ✓ AMC Home Page

Vision Statements...

he Army Vision

The World's Best Army, a full spectrum force -- trained and ready for victory. A total force of quality soldiers and civilians

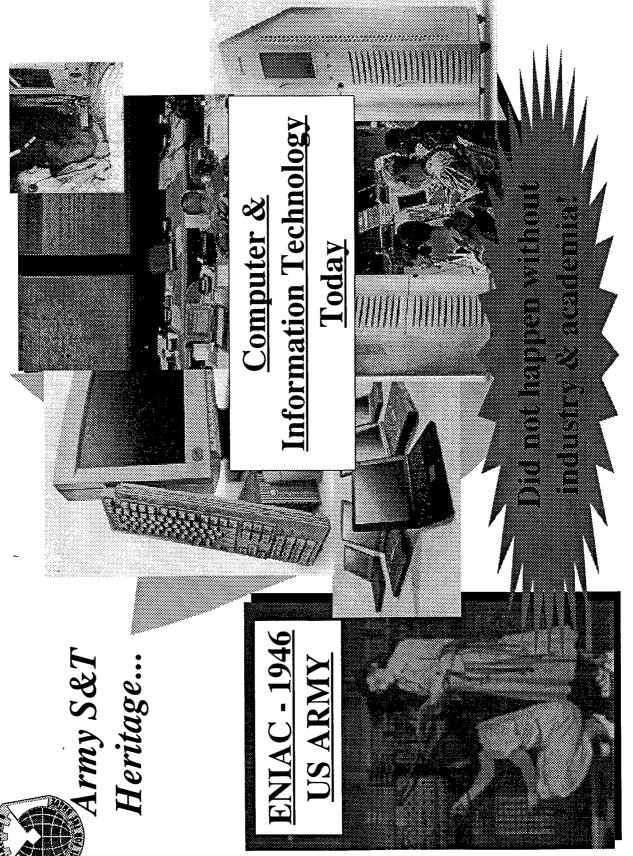
- A values-based organization
- An integral part of the joint team
- Equipped with the most modern weapons and equipment the Country can provide
- Able to respond to our nation's needs
- Changing to meet the challenges of today...tomorrow...and the 21st Century

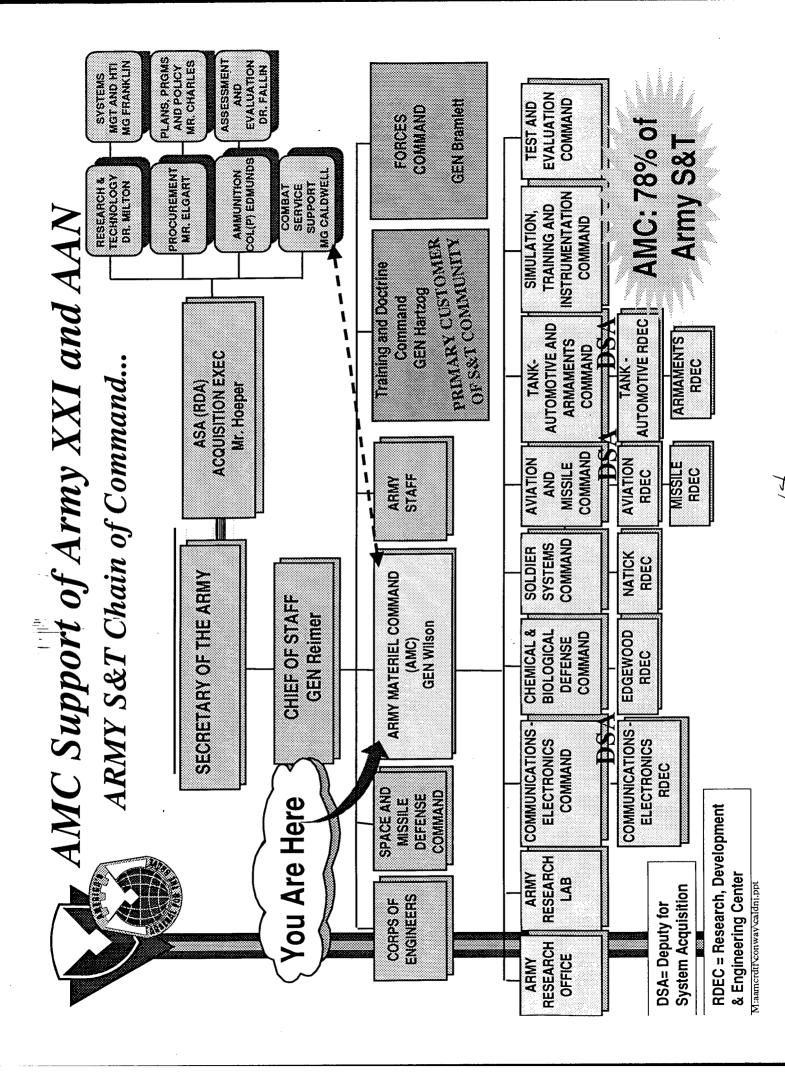
"Soldiers Are Our Credentials"

The AMC Vision

The leader in equipping and sustaining
America's Army through superior technology and responsive support, assuring world-wide power projection and decisive victory.

"America's Arsenal for the Brave"





TRADOC/AMC Partnership...

& Technology **AAN Science Battle Labs** Personnel at Advanced Concepts and Advisory & Working Groups **Technology**

Objectives

Battle Lab
Warfighting

Experiments

Battle Lab -

Technology II (ACT II)

Reviews

ATOMETROCA

Joint Workshops &

Workshops & Conferences

Force XXI

Foreign Technology

Insertion

International /

Experiments

Warfighting

Advanced

Idea Teams,

Integrated

Fielding

TRADOC

Requirements & Doctrine

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AMC

Technology & Materiel

AMC and Force XXI...

S&T Investment for Force XXI

ACTDs ATDs DECISIVE OPS INFO DOM AMC STOS \$350M FY 98 **PROJECT** SUSTAIN PROTECT SHAPE

Experimentation AWEs and BLEs ...

- Personnel at TRADOC
 - Infrastructure support
- System prototypes
- · Engineering/technical support
- Simulation

Fielding Force XXI

Central Technical Support Facility

Warfighter Rapid Acquisition

Process (WRAP)

11 Systems approved for 1997

PEO C3S

(CTSF)

AMC TRADOC

through AMC buying centers

· All WRAP procurements are

AMC manages 4

S&T Influence on Force XXI and AAN...

2025

2010

8661

Army After Next Army Warfighting Advanced Technology Strategic Research State Areacasta In 1 Army XXI/Joint Vision 2010 Applied Research (6.2) Advanted Leadings Excellenced Army of

S&T portfolio requires a menu of options.

Objectives

Demonstrations

Experiments



Army (S&T) Investment Strategy...

Mental Agility

Physical and Mental Agility

TRADOC (Requirements &

Doctrine)

ARMY XXI

AAN Battle Force

READINESS

Must balance current readiness with future readiness!

AAN 6.3

AAN DEVELOPMENT & FIELDING

CEVOLILIBRIES
TRADE-OFFS

ARMY XXI S&T (6.3)

FY 04

(Technology &

AMC

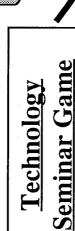
Materiel)

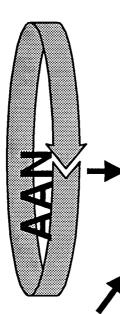
AAN S&T (6.1 & 6.2)

Evolutionary

ARMY XXI DEVELOPMENT, FIELDING & MODERNIZATION

AMC and AAN...





Army & Joint Planning

S&T Investment

Strategy



National Academy of Science

Army Science Board

AAN FORCE OBJECTIVES

> Direct Support

V Technology Build for Tactical War Games V Technology Teams for AAN War Games

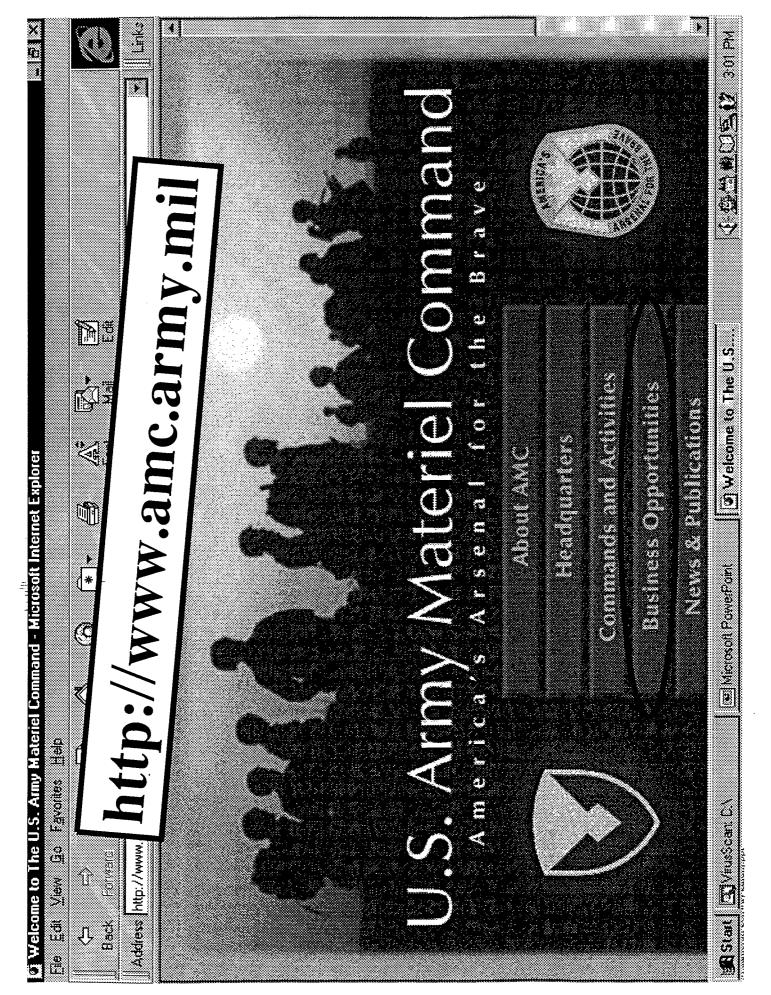
Performing78% of Army'stotal R&D

Workshops
(Biotechnology,
Robotics)

VFormulation of S&T Investment Portfolio ✓Integrated Idea Teams (Mobility, Fires)

AAN Force Objectives...

- Lighter, Faster, More Mobile Force
- ✓ Significant Reduction in Force's Logistics Burden
- Precision Strike Capabilities Which Require Fewer Munitions to Accomplish Mission
- Integrated Data Fusion From Multiple Sensors and Intelligent Decision-Making Aids for Commanders at All Levels
- ✓ Countermeasure Capabilities to Protect Integrity/Availability of Information and Sources
- ✓ Bioscience/Human and Organizational Enhancement to Improve Soldier Performance and Capacity
- ✓ Power Sources Other Than Fossil Fuels & Batteries
- ✓ Ultra-Reliable Systems



Back Up Charts

AMC and Industry: Partnership for the Future...

Army After Next requires AMC & Industry to:

- Align for jointness
- Leverage outsourcing and privatization
- Manage information and knowledge based systems
- Manage sustainment from factory to foxhole
- Tighten relationship with battlefield operations



Ways AMC interacts with industry

- Advance planning briefings to industry
- Small business symposiums
- CEO conferences/AUSA conferences
- Acquisition reform conferences
- Advanced Concepts and Technology II
- Small Business Innovation Research

Army After Next

- Smaller, more lethal and agile
- · Largely CONUS base
- Depend heavily on technology
- Based on situational awareness

Require anticipatory logistics

Making Technology Work for Soldiers...

Technology Generation Quick Response Office

Field Assistance in S&T

Science, Technology & Basic Research

Advanced Concepts and Technology II Small Business Innovation

Research

Warfighting Rapid Acquisition Process

Acquisition Reform Management

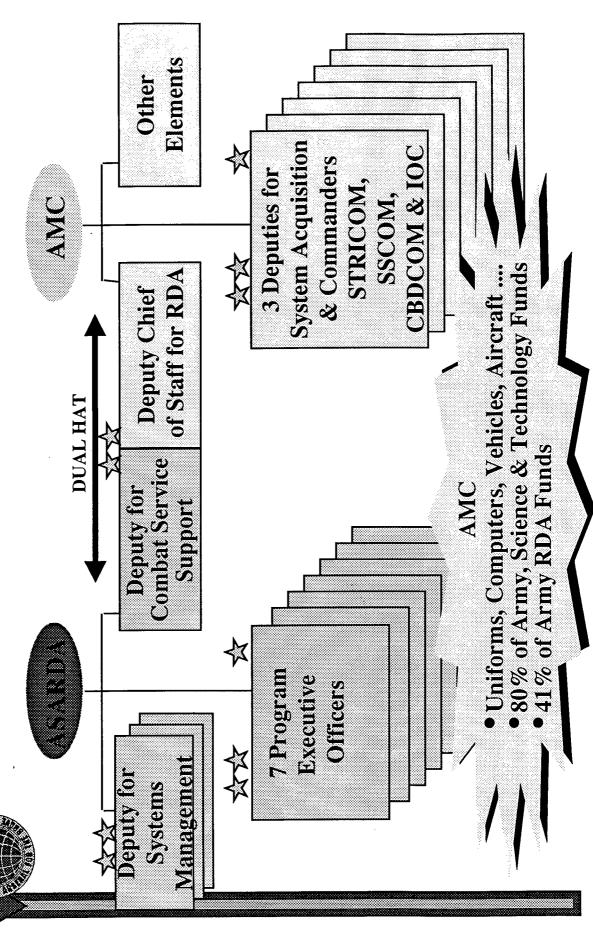
Excellence. Acquisition

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Key Functions of the AMC DCS for RDA

なな

DCSRDA Wears Two Hats...



Technology Seminar Game: A key S&T Investment Strategy... component to the Army's

S&T Investment Strategy Commercia or DoD?

> A world of good ideas! Industry DoD

Technology

<u>Seminar</u>

Game

Army Science Board Academia

National Academy of Science International Programs

Next AAN War Game WAN Spring

War Game

AA:XCycle

0 N

S&T Influence on Force XXI and AAN...

Army After Next Strategic Research 2025 风风的有人的人的人的人的人的人 Basic Research (6.1) Army XXI/Joint Vision 2010 Apolled Researon (6.2) Advanced Technology 2010 Army Warfighting Excellence Army of 1998

S&T portfolio requires a menu of options.

Objectives

Demonstrations

Experiments

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Marine Corps Warfighting Laboratory



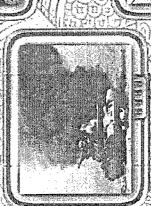
Beigndier General (Sel.) Timothy E Denovan

EXAMPICA OLOPSELLY

WASSING TRANSION POILOR









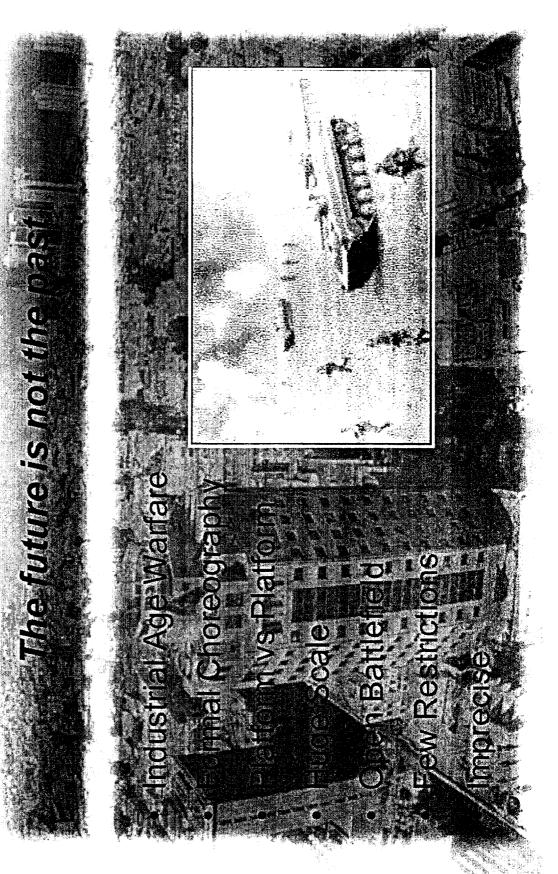






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Simplication in flection and and

S.Jeowelewaler

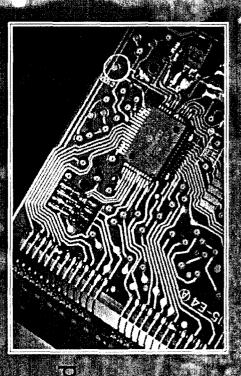
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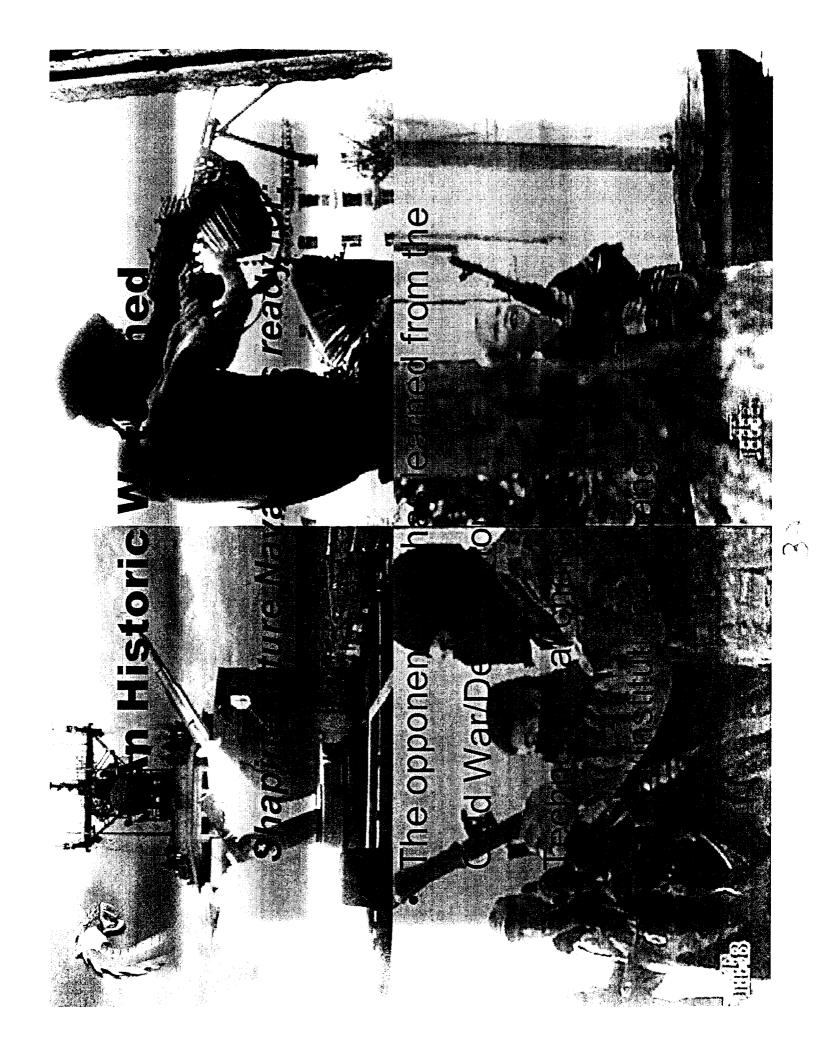
o Use of asymmetrical approaches by

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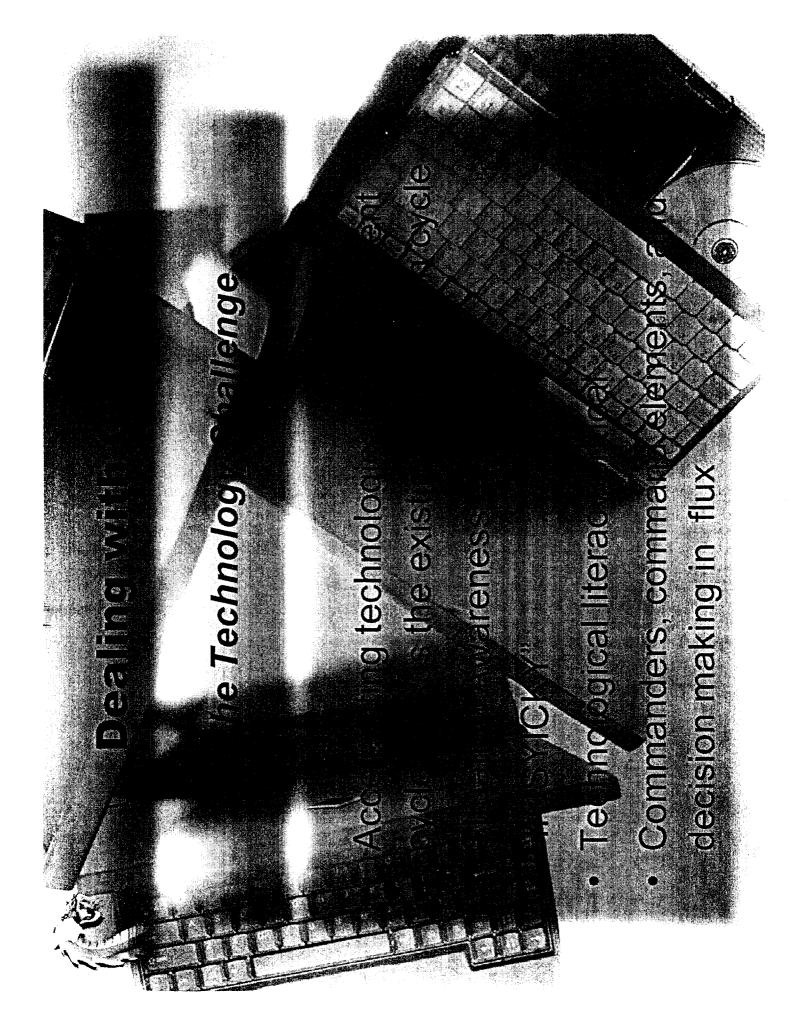
াদীজভোষামূল বুসুষাকোগায়ে**y of advanced** ectinologies

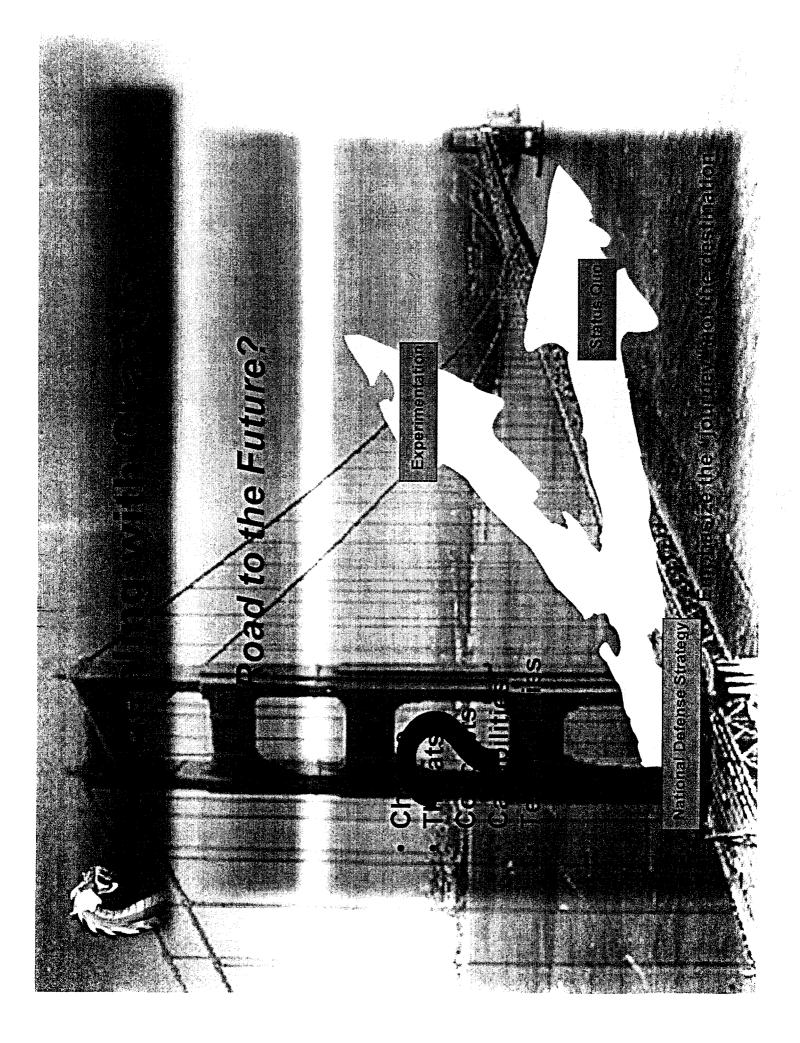
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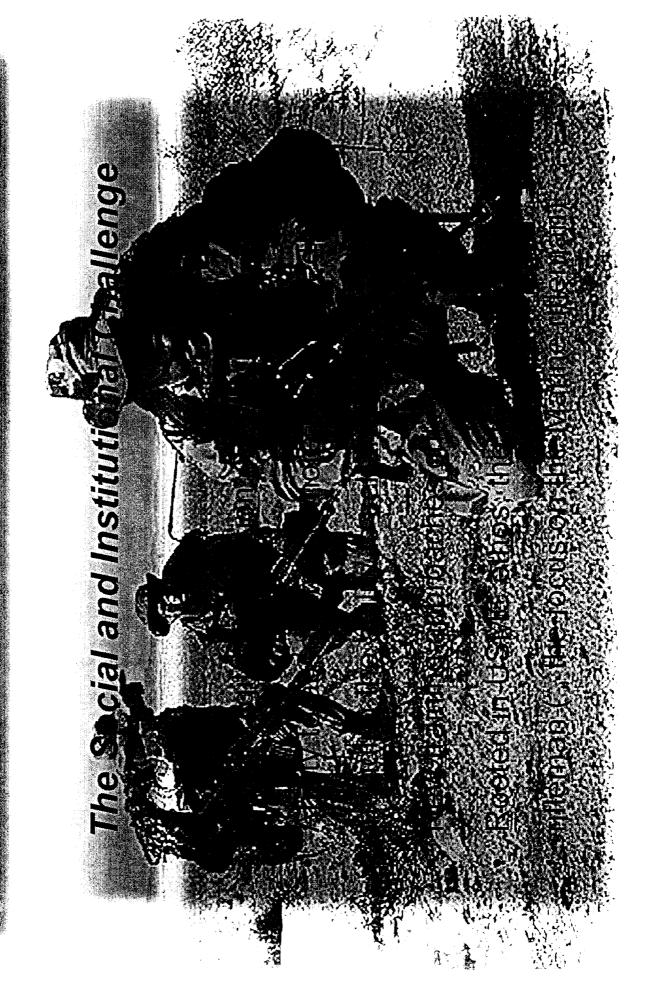


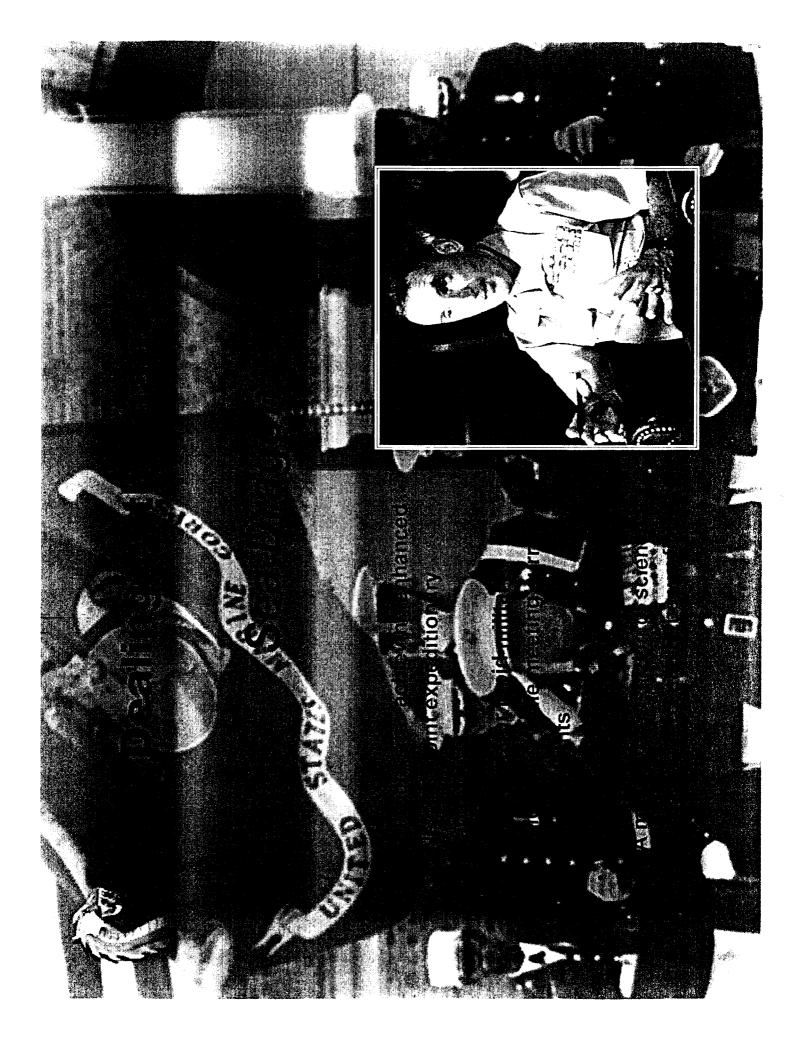


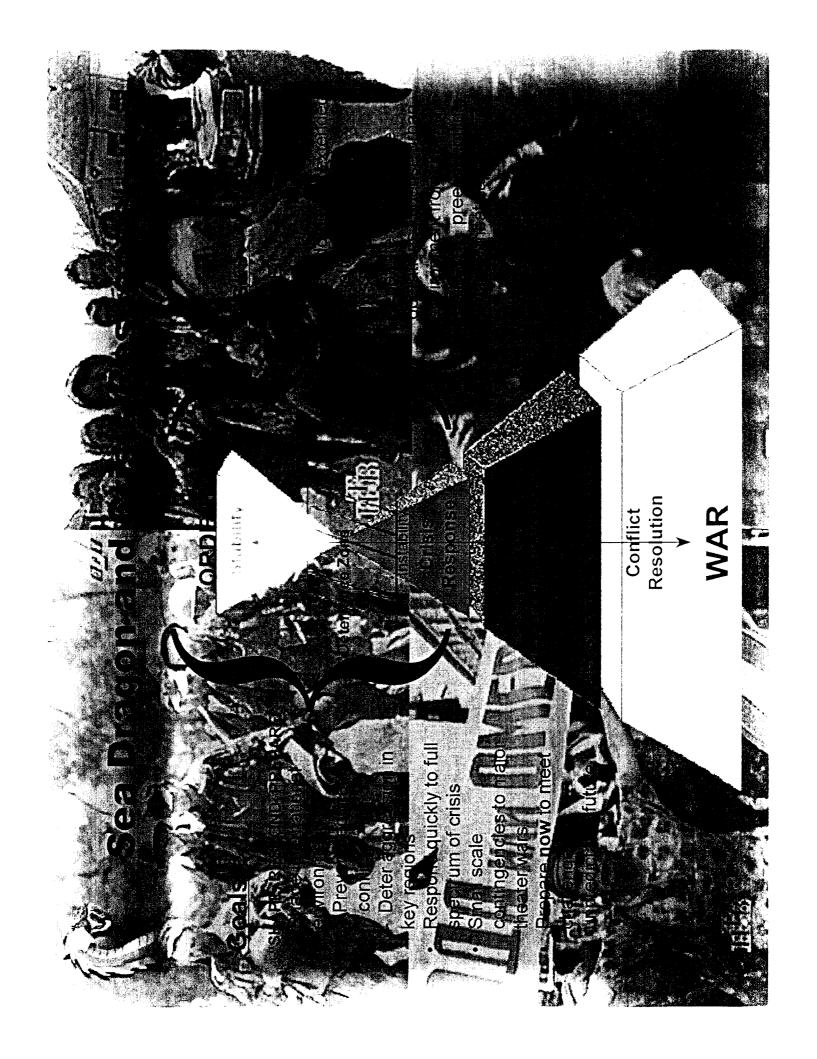










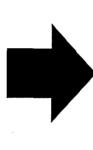


Sea Dragon and Relevance

Shape the international environment...prevent conflict, deter aggression...in key regions

HUNTER WARRIOR

Enable modest forward deployed forces to dominate large areas of the littoral and to defeat heavier forces to support Joint follow-on ... and



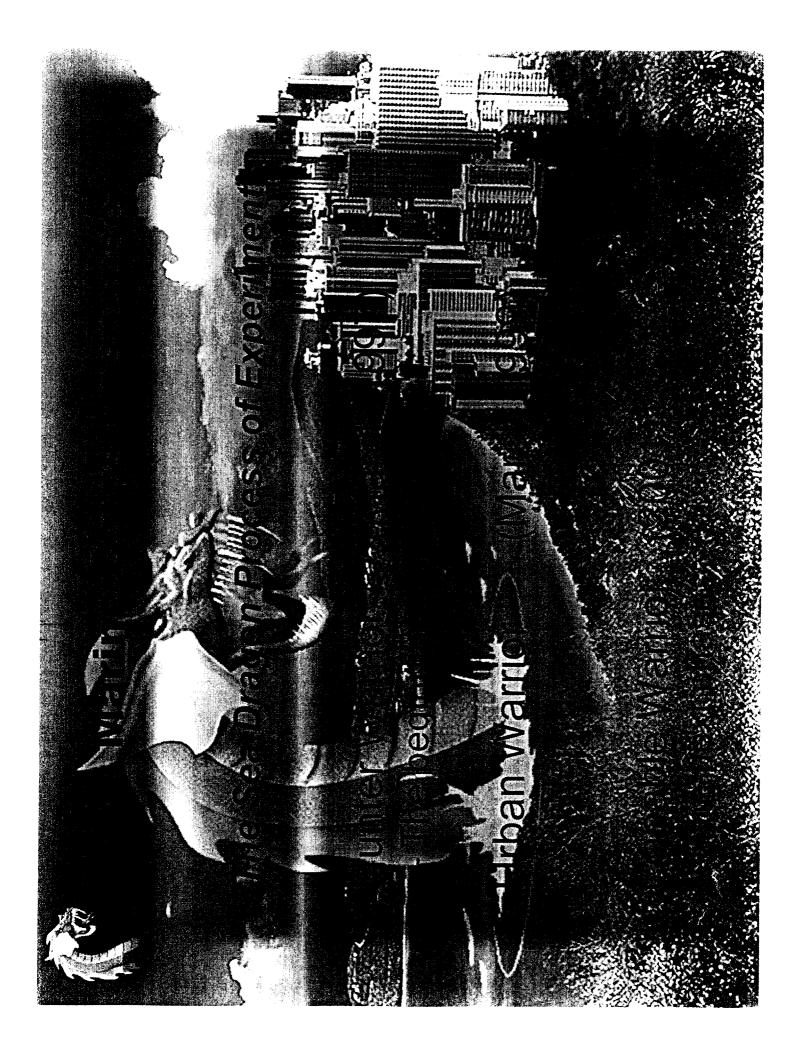
Develop afloat and early arriving forces that are preeminent in penetrating and executing urban operations... then

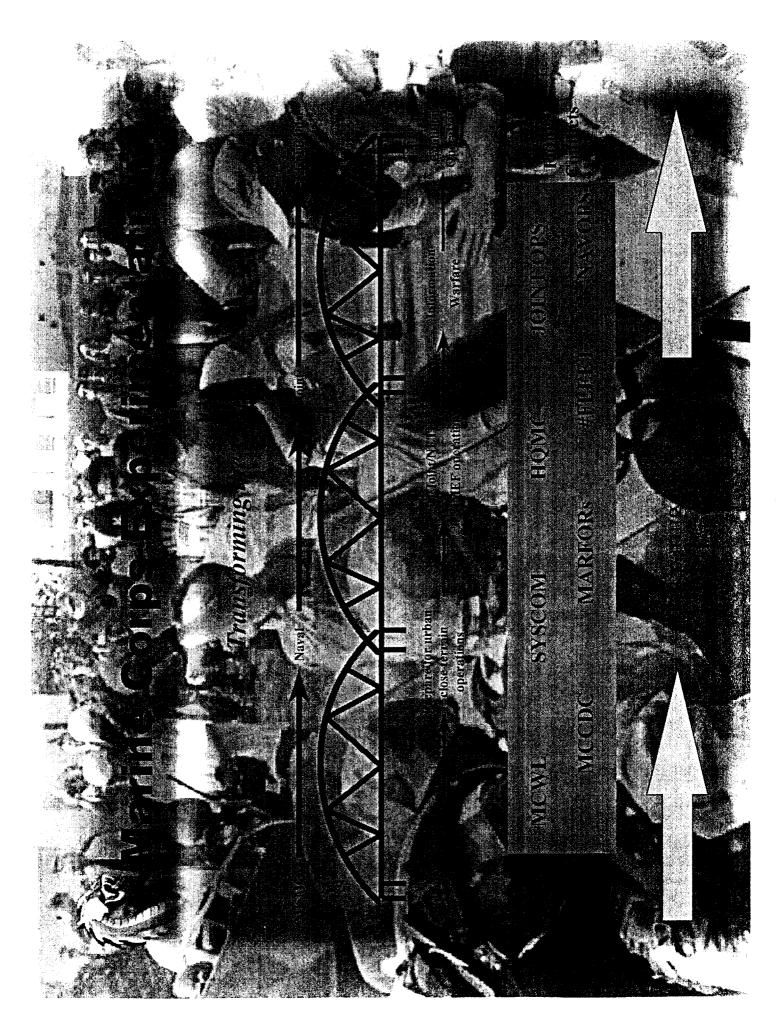
Respond quickly to the full spectrum of crises...small scale contingencies to major theater wars

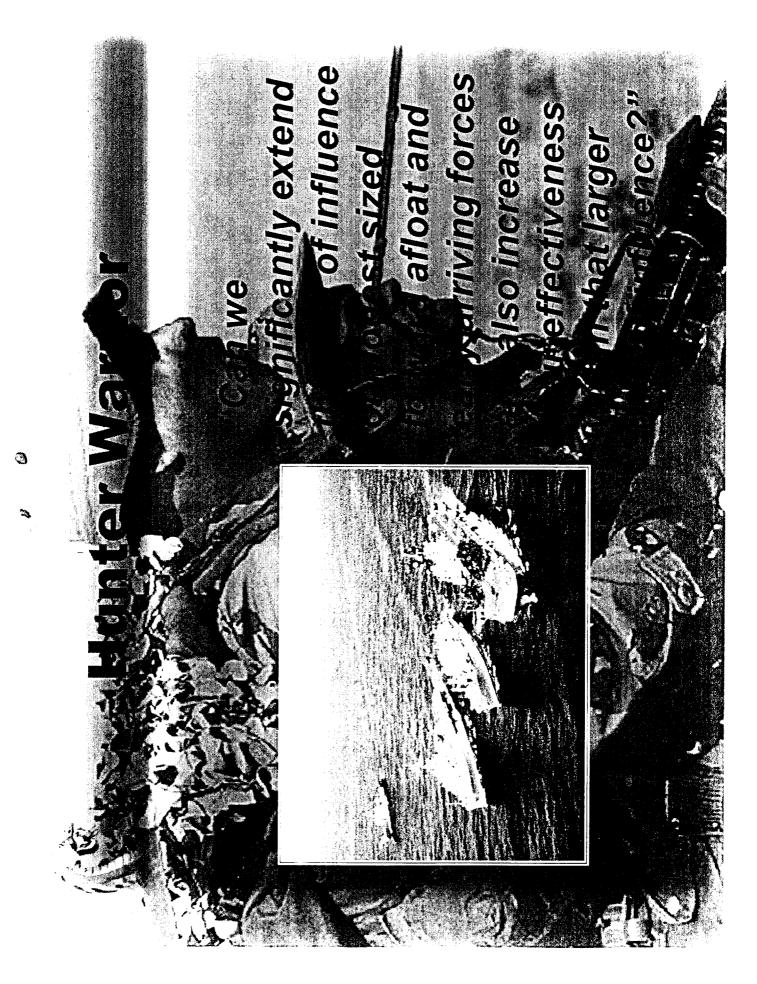
URBAN WARRIOR CAPABLE WARRIOR

Integrate reforms to meet the full range of future capabilities.

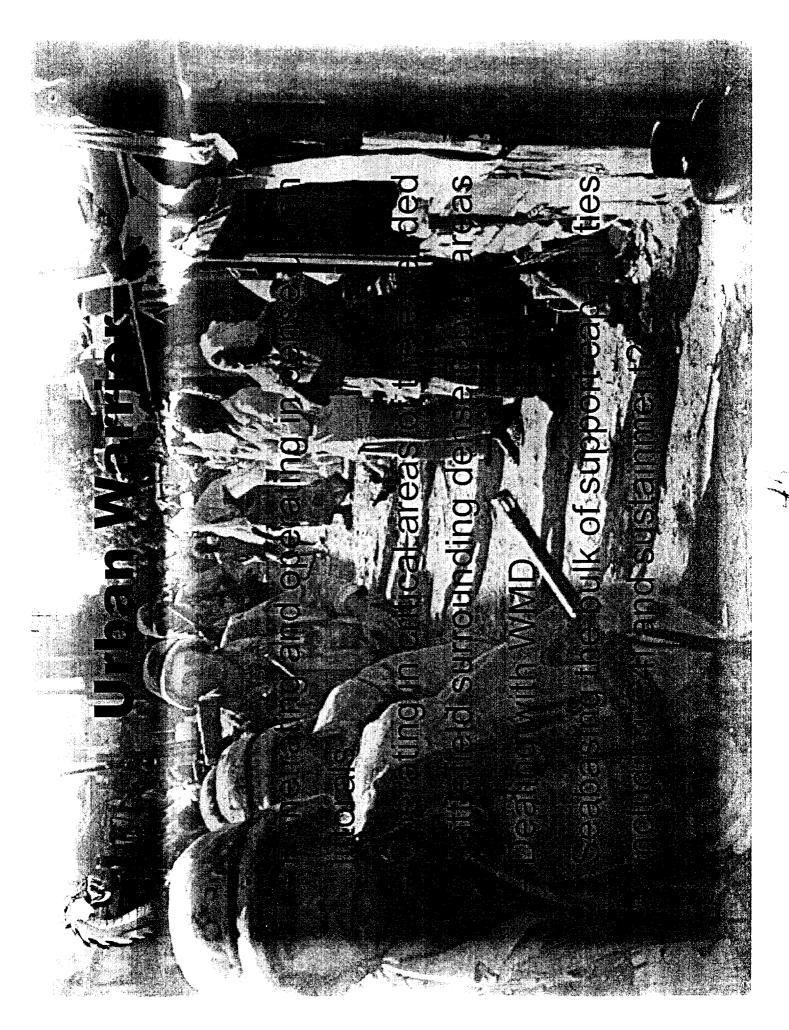
Prepare to meet the challenges of an unpredictable future

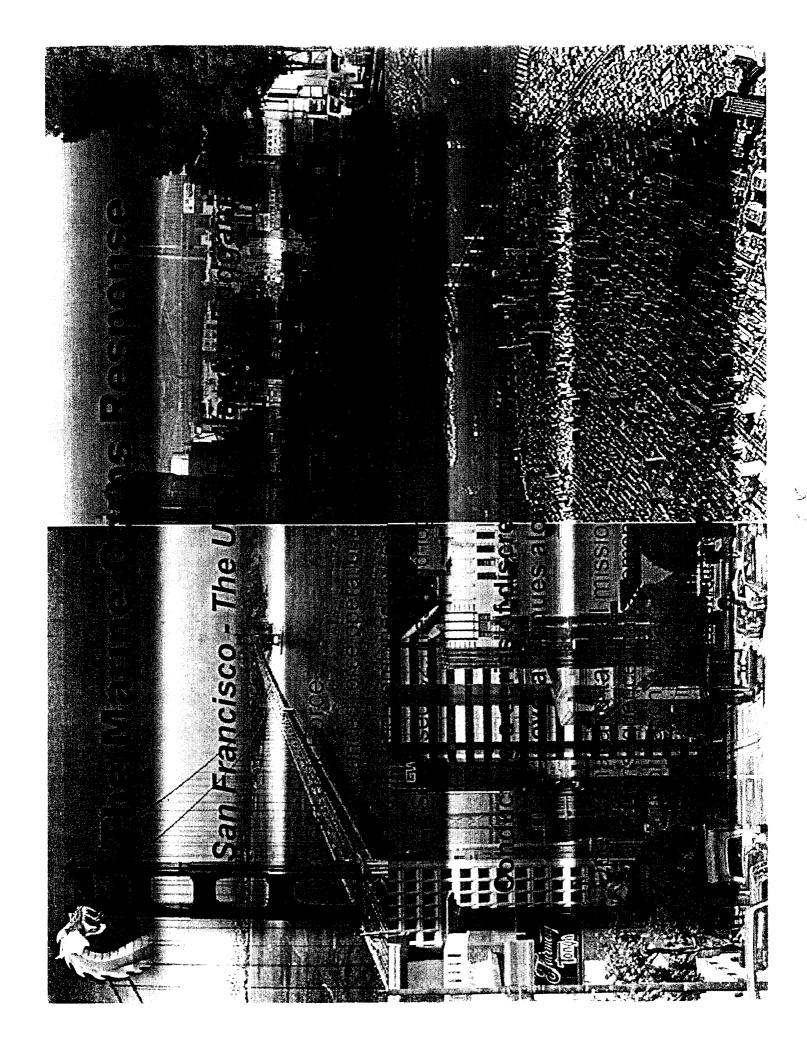


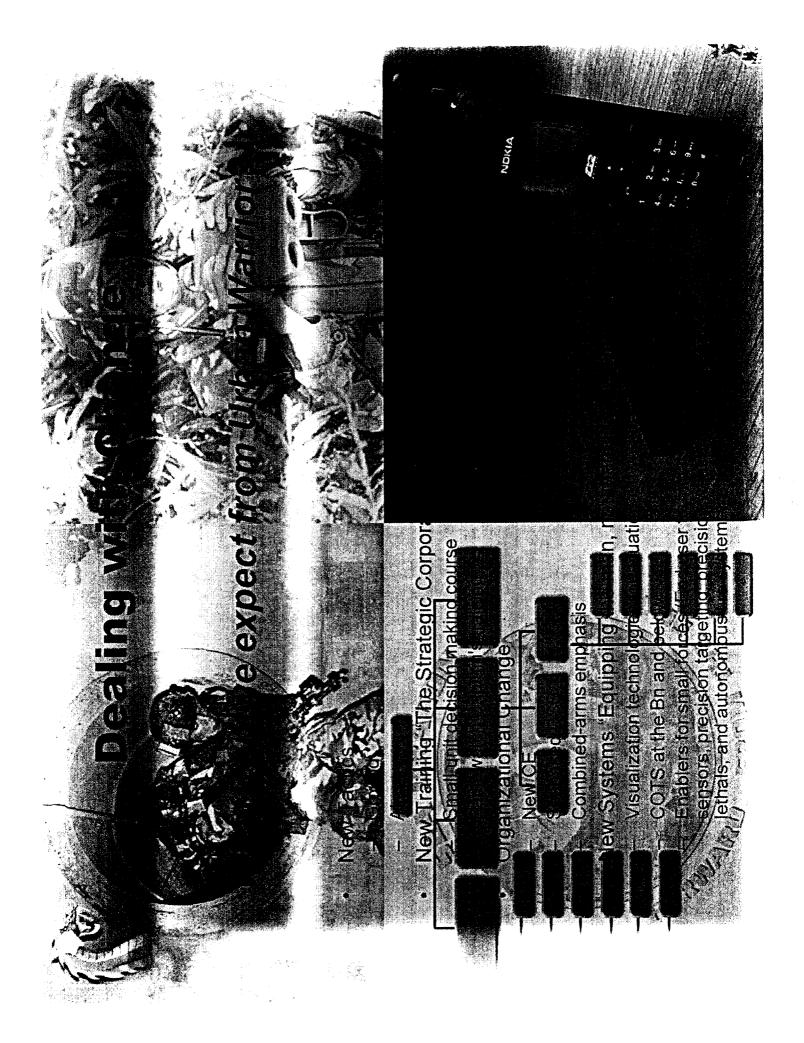


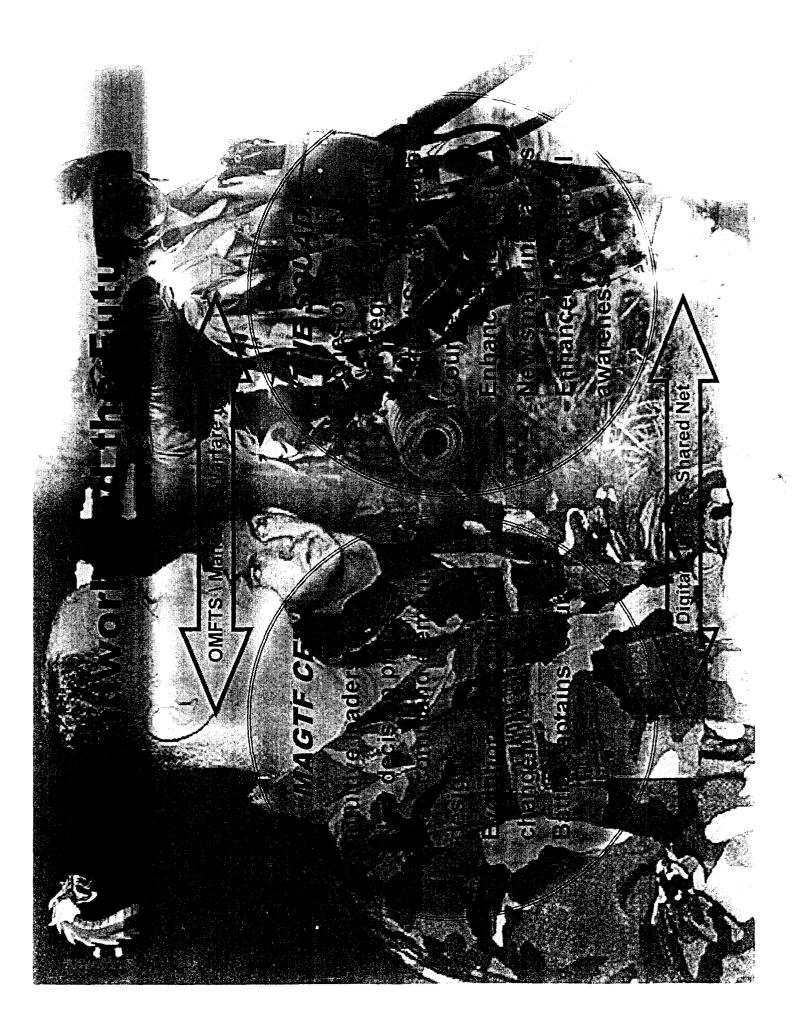




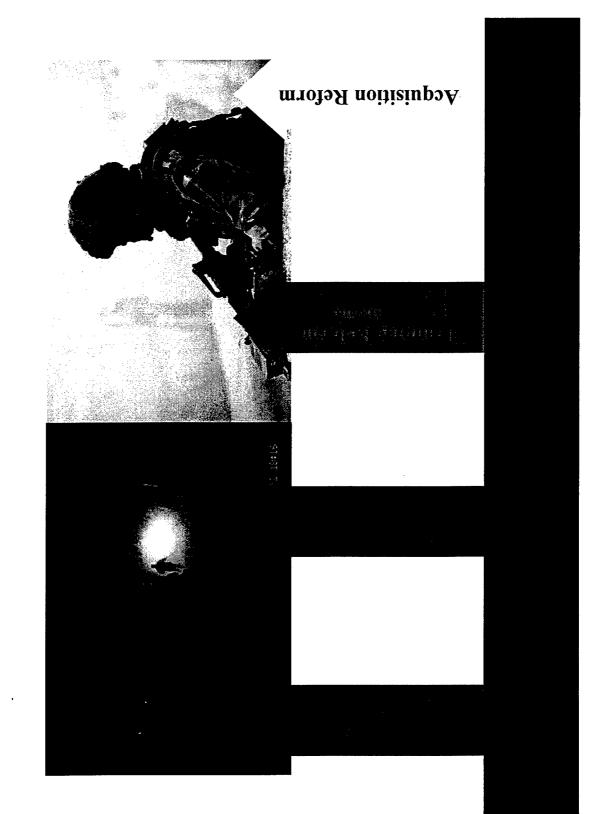




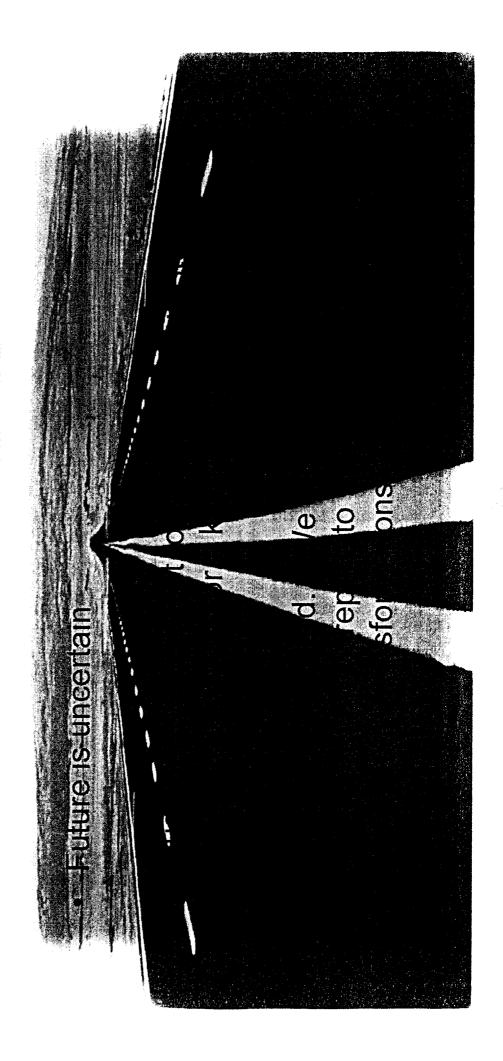




An Emerging 21st Century Corps











AGENDA

Division Mission / Road to War

DAWE Hypothesis

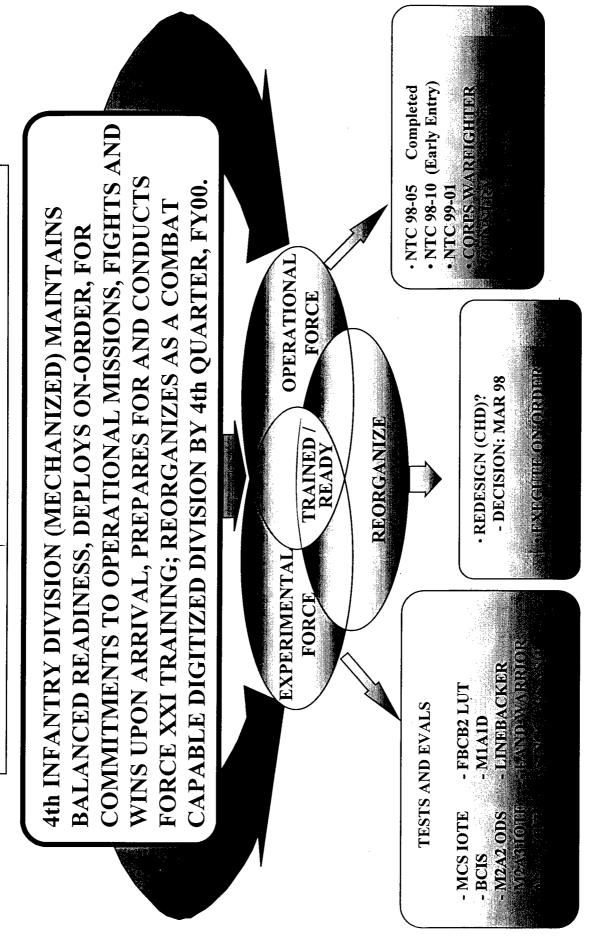
How We Fight

Exercise Construct

Collective Insights

DTLOMS Implications

NOISSIM NOISIAID



FEB 99 REDESIGN STAFFING 2BDE NTC INITIAL **OCT 99** FBCB2 **IOTE** DEC 98 ZON 67 DAWE WFX <u>≥</u> REDESIGN COUNCILS JAN 98 FEB 00 **WFX RU 86 AON** S N N 1 BCT <u>≥</u> RAMP-UP **FEB 98** 2 BCT **SEP 97** NTC DE CT **SEP 98** 3BDE M1A2 SEP **FIELDING** NTC MAY 00 DIRECTORS **BOARD OF** 3BDE 70L 97 **FEB 98** NTC DOCUMENT ROAD **OCT 98** FDD RAMP-UP 76 NOC #1 MCS IOTE FIELDING RAMP UP **APR 98** OO NOC **M2A3** AUG 98 NTC 97-06 SEMINAR 4 BDE NTC **APR 97** BCTP AUG 00 (EXECUTE?) REORG 4 BDE NTC FDD JTF XXI MAR 97 **AUG 98** FBCB2 LUT **SEP 00** FDD / **36 NOC** IOTE MCS

= -

DAWE HYPOTHESIS

IF:

organizational concept enables information dominance and enhanced battle command The Force XXI division operational and capabilities.....

THEN:

Increases in lethality, survivability, sustainability, and tempo will be gained across the force.

BAY XX NOISING

HYPOTHESIS

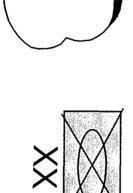
IF... THE FORCE XXI DIVISION OPERATIONAL AND ORGANIZATIONAL CONCEPT THEN...INCREASES IN LETHALITY, SURVIVABILITY, SUSTAINABILITY, AND ENABLES INFORMATION DOMINANCE AND ENHANCED BATTLE COMMAND TEMPO WILL BE GAINED ACROSS THE FORCE.

OBJECTIVES

- DEVELOP AN EASILY TAILORABLE, MODULAR FORCE DESIGNED AROUND INFORMATION.
- DEVELOP THE TACTICS, TECHNIQUES AND PROCEDURES (TTPs) FOR AN INFORMATION AGE FORCE
- DETERMINE THE IMPLICATIONS OF TTPs, ORGANIZATIONS AND TECHNOLOGICAL ENHANCEMENTS ON SOLDIERS/LEADERS.
- · SIMULTANEOUSLY EXPERIMENT AND INTEGRATE MATERIEL, FRAINING AND ORGANIZATIONAL CHANGES.
- · EXPERIMENT WITH ENHANCED BATTLE COMMAND CAPABILITIES.

O SYSTEM LIST

BATTLEFIELD PLANNING & VISUALIZATION TRANSACTIAL DATABASE (DISTRIBUTED) BATTLEFIELD VIDEO TELECONFERENCE SECURE HIGH BAND WIDTH COMMS BATTLE COMMAND BATTLE COMMAND "ON-THE-MOVE"



HOMESTATION SPT NETWORK: CONTRACTOR SPT FUNDING BATTLESTAFF COFT (CTSF) TRAIN/SUST ROMTS - ABCS/GCSS-A **CSTAR at CTCs CBS SSMs**



LOGISTICS MOB / SURV

> FAADC2 ADA

✓ AFATDS FIRE SP1

INTEL

MANEUVER

/ FBCB2 KIOWA X AH64-D

/ MCS/P

ASAS × TUAV

MLRS

csscs

MTS PLS

X *IMF (RAPTOR **× M93A1 FOX** DTSS

/ LINEBACKER Slew-To-Cue) X AVENGER

X STRIKER

CGS/GSM

TROJAN **JSTARS**

X MOBILE C2

× AQF

X LLDR

SENTINE

X WOLVERINE ×*GRIZZLY

×*JWRS

LONG RANGE SMART MUNITION

(I-REMBASS

V M1A2SEP M2/M3A3 ×* RAH-66

? LRAS3

× C2V

X Q-37 BLK I ✓ PALADIN

MECHANIC

SYSTEMS

× *TIGER

× MC4 × *DVE

SINCGARS-SIP **EPLRS-VHSIC** Data Radio ATM/FSEN SMART-T ISYSCON SPITFIRE **HCLOS** NIN >

*GCSS-A

FRS-H

SIDPERS3

*WIRELESS LAN

× *FDR

GBS

* Not available in FY00

X CRUSADER

X BFIST

X MFCS

GBCS-1 / IMETS

×*FSCS

AMPS

< *DMS</pre> × *ACN

/ *PCS

ABOVE THE LINE: O&O WITH ACCEPTABLE RISK AND REDUCED CAPABILITY BELOW THE LINE: REQUIRED FOR FULL O&O CAPABILITY

FORCE STRUCTURE

CAV SODN

FORCE XXI HEAVY

DIVISION DESIGN

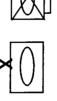
×

Trp has 8 Helo (Vice 12) NBC Recon Plt Added

MP Company

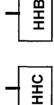
One Less GS Plt 3 Sqds per Plt











HHC

ΔE

SIGNAL BN

GBS-BADD





BAND





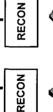


RTOC

No LRSU-D

MI Bn









BSFV-E Crew reduced to 4

12 Avengers Added

ADA BN

UAV\GBCS\AQF

Larger ACE

ARMOR BN

EAD/RC Augmentation

45 Platforms

CAMB

MLRS Bn 2x9+TAB

Cannon Bn 3x6

ARTILLERY

Minus AT Co ZMLRS,1CANNON HHB+SVC to HHS 2 R FA BDES 2x9 + 5

AVN Bde

Added LUH Plt to GSAB 1 AHB vice 2

DISCOM

Maneuver Adds all





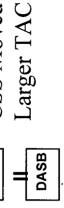
HHC





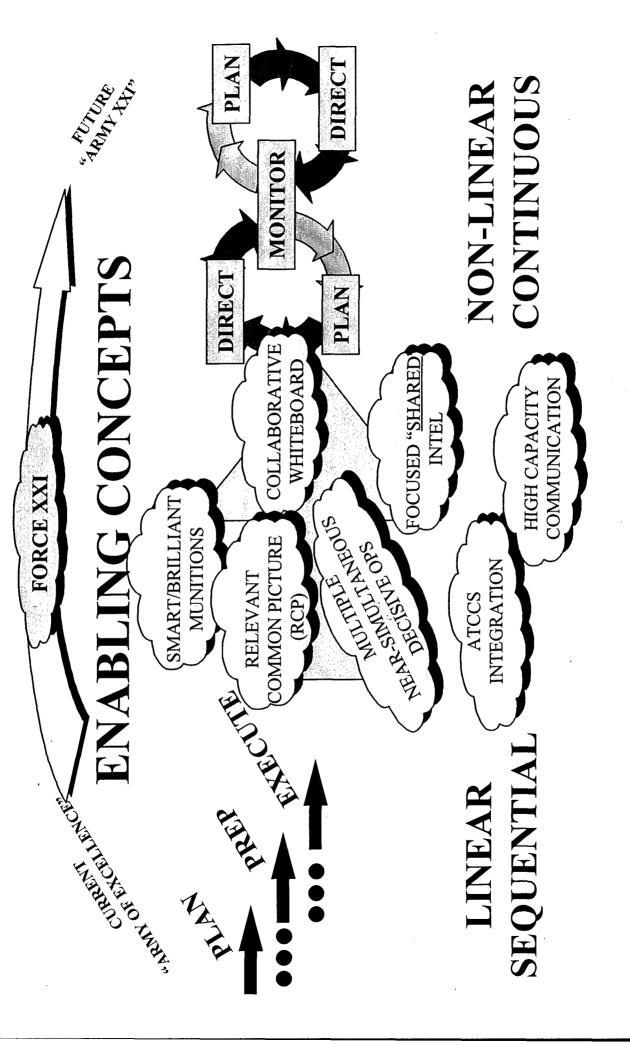




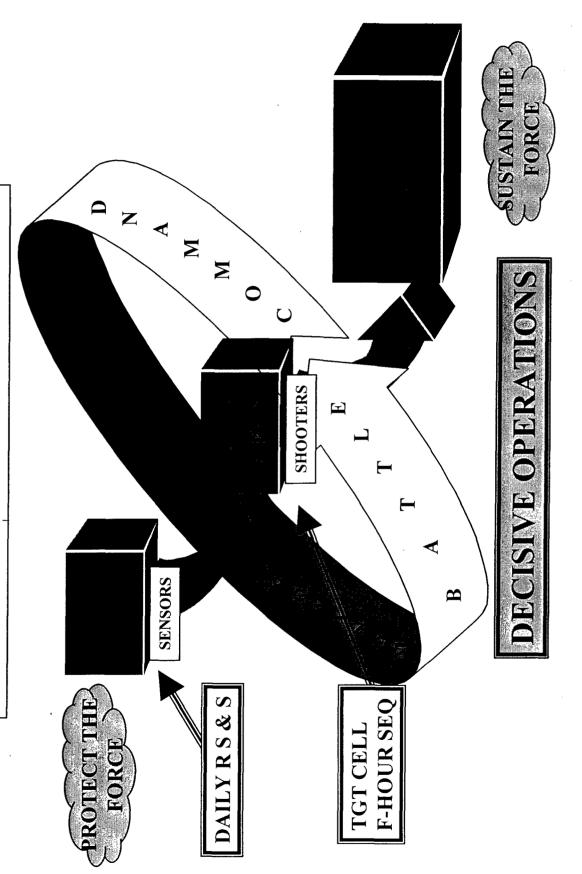


ENG BDE

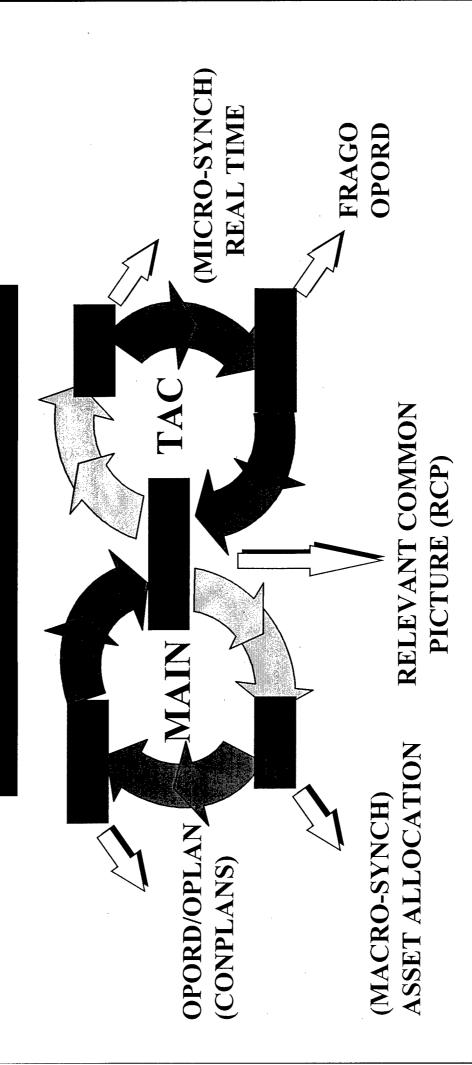
Larger DIV staff No ENG BDE



HOW WE FIGHT

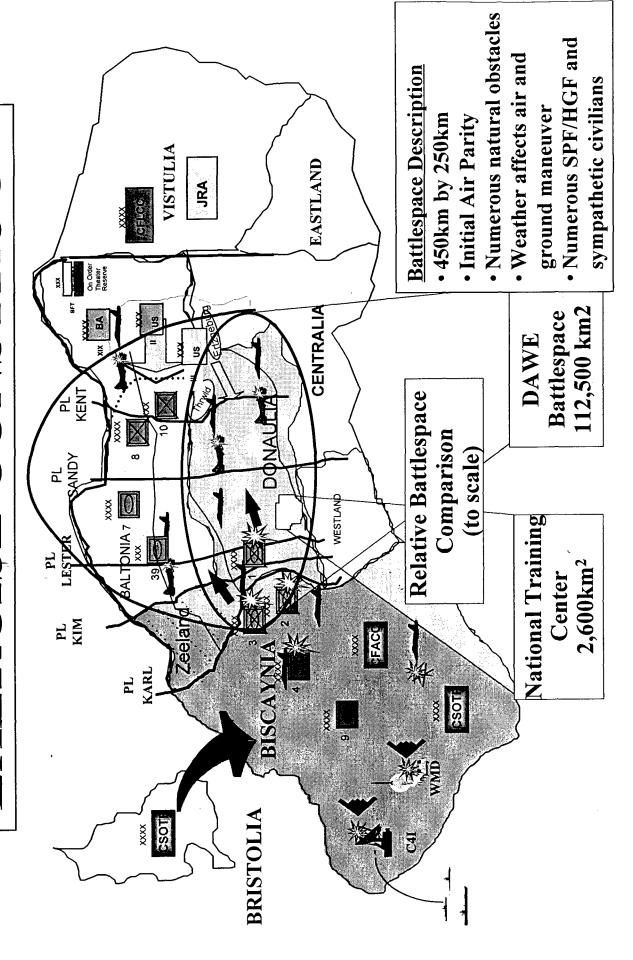


HOW WE FIGHT

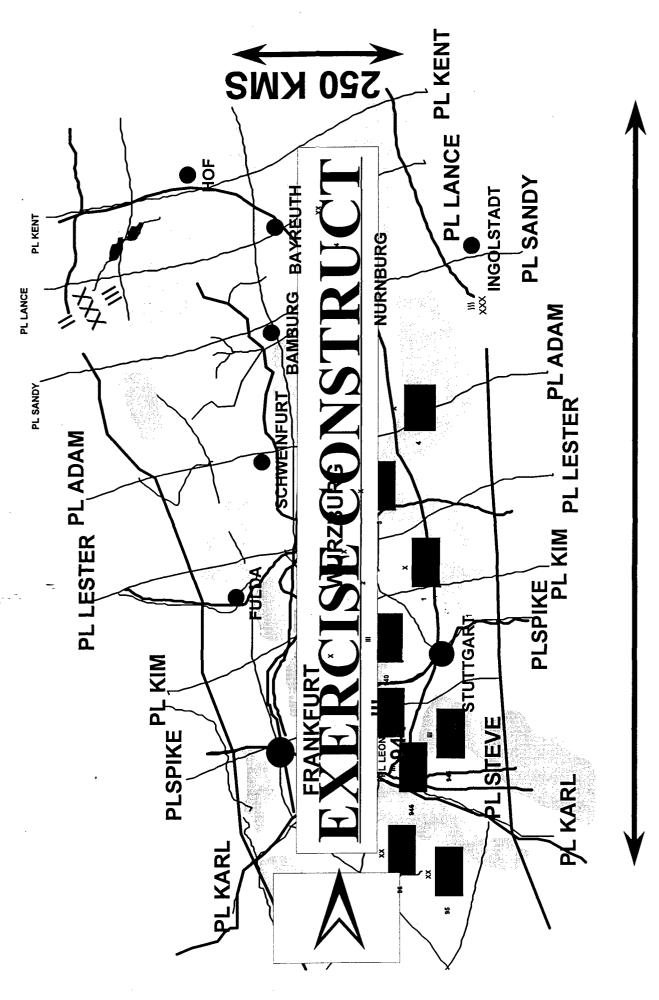


EXERCISE CONSTRUCT

<u>=</u>



human assisted (UAV), and human(Scouts)... each cued by the other... with our knowledge of the enemy improving in granularity from reconnaissance, fires, and maneuver which amplifies the effects and benefits of each... "There is an evolving relationship among reconnaissance is electronic (JSTARS), electronic to human....

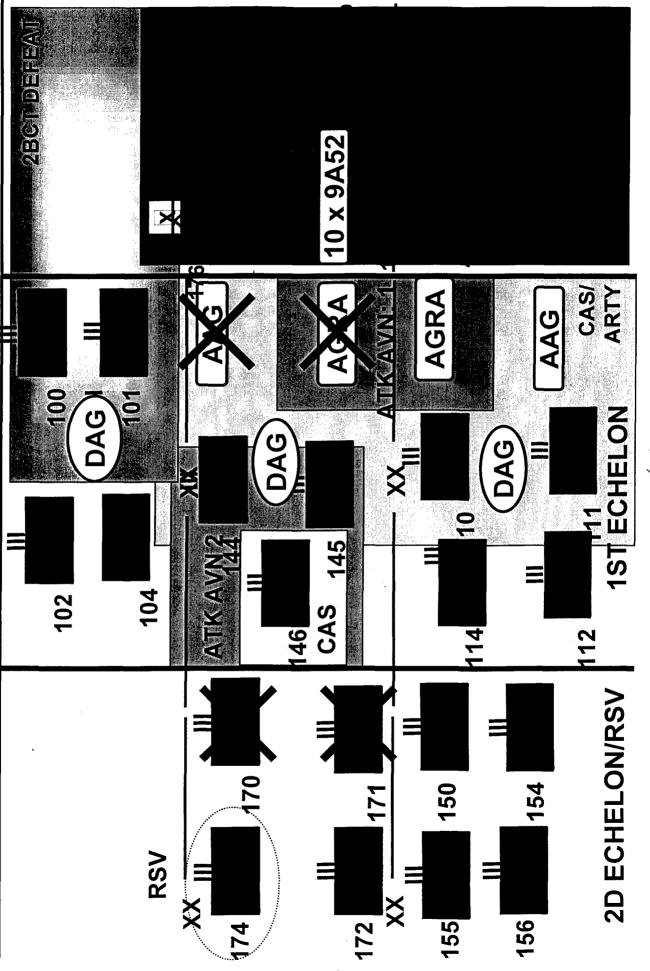


450 KMS

TASK ORGANIZATION

DIVISION 4 BDE 3 BCT 2 BCT 1 BCT

ATTACK STRATEGY

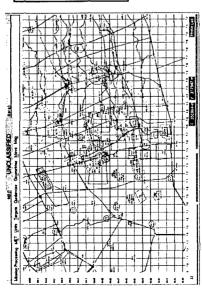


Maneuver systems also perform the necessary MG Wallace, CG 4ID becoming the defeat mechanisms of choice." Maneuver systems protect and position fires enemy using ambush techniques which are positioning and direct fires so that indirect task of fixing enemy formations through fires and attack aviation can destroy the forward extending their tactical reach.

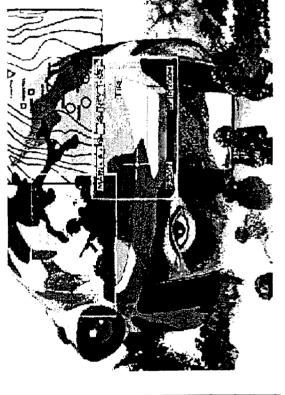
If you're looking for a bumper sticker, it might read:

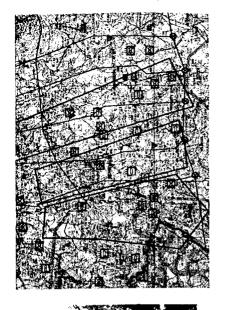
Battlespace, with 25% fewer Combat Platforms Enemy, in half the Time, over three times the "The EXFOR Division killed over twice the using Information Age Technology."

Outcome of the fight Matters but... How it happened is More Important!



INSIGHTS

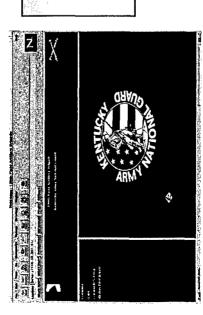




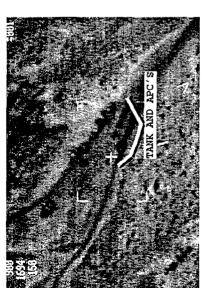
WINNERS:

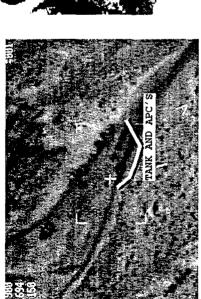
- Advanced Warfighting Experiment (AWE) Process
- ATCCS Integration (we've come a long way)
- Organizational Designs (Ex.. Cmd and Attack Bn & RC FA Bde) Harnessing / Packaging / Processing Collaborative Information
- Central Testing Support Facility (CTSF)
- Numerous BOS / Across DTLOMS Implications

9



SLHUSISNI









◆ WINNERS:

- AWE Process
- ATCCS Integration
- Harnessing / Packaging /Processing Collaborative Information
- Organizational Designs (EX.. CM AND ATK BN and RC FA BDE)
- Central Training Support Facility (CTSF)
 - Numerous BOS / Across DTLOMS [mplications

- Visualization Tool (BPV) Battlefield Planning and
- Collaborative "White Board"
- Analysis Control Team (ACT)
- **Extended Range Smart Munitions**
 - Army Missile Defense Work Station (AMDWS)





INSIGHTS





◆ WINNERS:

- AWE Process
- ATCCS Integration
- Harnessing / Packaging / Processing Collaborative Information
- Organizational Designs (EX.. CM AND ATK BN and RC FA BDE
- Central Training Support Facility (CTSF)
- Numerous BOS / Across DTLOMS Implications

□ MATERIAL WINNERS

- Collaborative "White Board"
- Extended Range Smart Munitions AMDWS

STILL NEEDED:

- Mobile C2 Nodes / Platforms
- High Speed Capacity Commo Non Line of Sight Wide Area
 - Network



C2 AND BATTLE COMMAND



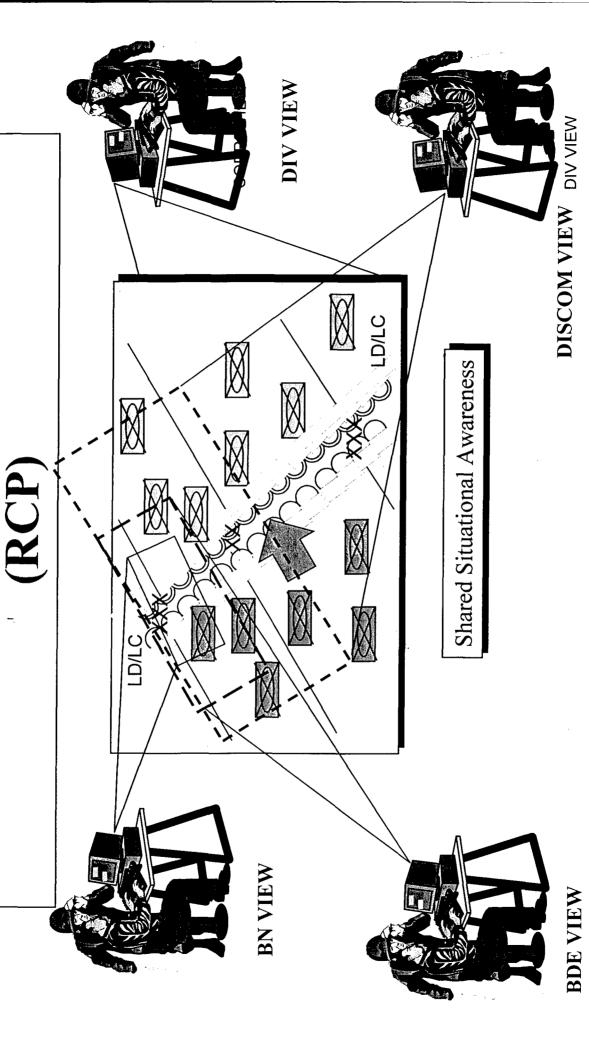
CAPABILITIES

- · Technology and digitization
 - -Collaborative VTC
- -Electronic Whiteboard -BPV
- •Relevant Common Picture (RCP) via ATCCS

CHALLENGES

- •C2 under demonstrated tempo
- •Integrating and supporting "non-digitized" units
- •Maintaining focus -Intelligence
 - -Fires
- -Information Operations

RECEVANT CONVONENT TO THE



J ...



SINCE MANEUVER





- Maneuver protected / positioned fires then:
 - -- fires, employing long range precision munitions, limited enemy's capability to maneuver which ...
- -- set the conditions for decisive maneuver

CHALLENGES

- •High Value Asset (HVA)
 protection (area vs. dedicated support)
 - By pass criteria
- Dynamic "re-task" organization

Dedicated Fire Support (DS "like" "Find-kill-finish" engaging at max ranges, forcing a "red zone" fight ·Creation of a "digital-downlink" •Maneuver protecting fires and from an aerial platform Y: 102219 m IRE POTENT fires) for Aviation exploiting success X: 175432 m /FR on our terms MANEU Mission Processing 32 0549 0542 0550 1548 0547 0545 0543 0546 0551

COLLECTIVE INSIGETS INTELLIGENCE

CAPABILITIES

- DOCC linkages (via ATCCS) enabled real time detection and attack
 - ELINT targeting procedures
- •Greater INTEL range permits deeper maneuver / fires employment options

CHALLENGES

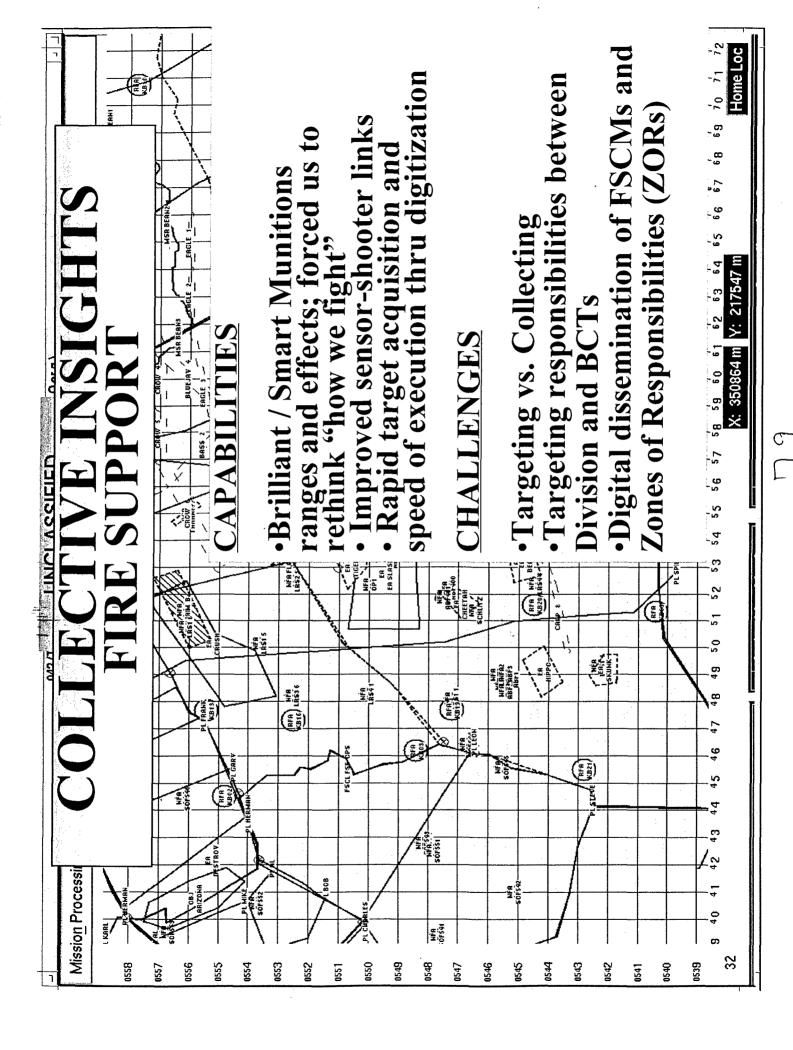
- Automating BDA and timely analysis
- Enemy attempts to degrade your Intel-Fires effort (ex. moving slower than (-Stars threshold)
- Sensors create vulnerabilities
- · Targeting and Fires handoff

NTELLIGENCE ENSIGHTS NTELLIGENCE STATEMENT S

FUTURE POTENTIAL

• Digital reporting links (ex. AFATDS - ASAS)

•Quicker planning and execution in support of shaping operations



DILONS IMPLICATIONS

Leader Development **O**rganizations Soldiers Materiel Training DEVELOPMENT Doctrine LEADER **TRAINING** FORCE MIX DOCTRINE EQUIPMENT SOLDIERS QUALITY MODERN

DTLOMS IMPLICATIONS

MATERIEL

- UAV& JSTARS

Div Command / Attack Bn

ORGANIZATIONS

- CAB (45 systems)

- M270A1 MLRS
- Crusader
- Smart munitions
- Block II Radar

- Dedicated contractor support

RC "habitual association"

ACE enablers

FSC (centralized log)

BRT Striker Platoon

Continue CP design analysis

FORCE

- Apache Longbow
- Commanche
- A2C2S
- CP Platform

MODERN LEADER EQUIPMENT DEVELOPMENT

SOLDIERS

- Establish a digital PEOPLE MOS
- Provide assignment stability
- Emerging TTPs

DOCTRINE

DOCTRINE

- Non-digital unit integration
- Two doctrinal sets?

LEADER

DEVELOPMENT

- CTSF Key
- Digital Staff Drills (STAFF EX)

TRAINING

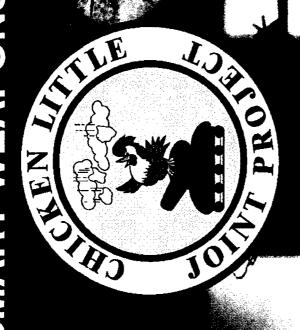
- Train & Experiment simultaneously

TRAINING

- CTSF is fundamental
- Digital vs. non-digital
- Expand simulation drivers

%

SMART WEAPONS



DESTRUCTION NOTICE: Destroy by any method that will prevent disclosure of contents or reconstruction of the document.



Briefer: J. Michael Heard



CHICKEN LITTLE MANAGEMENT OVERVIEW

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US ARMY MATERIEL COMMAND

COMMANDER
AIR FORCE DEVELOPMENT
TEST CENTER

JOINT MOA

AIR FORCE MR JACOB CO-CHAIRMAN

BG NANCE CO-CHIARMAN

COMMANDER AVIATION AND MISSILE COMMAND

STEERING COMMITTEE

5 AIR FORCE

TECH ADV, 46 TW EGLIN, MR JACOB ADV, A/S MUN, ACC / DRP LANGLEY, COL LINCOLN

DEP DIR, MUN DIR, AFRL EGLIN, MR KORN DEP, ARM PRDT GRP, ASC / WM EGLIN, MR BURDA

CHF, MUN TEST DIV, 46 OG EGLIN, MR BROWN

5 ARMY

PEO TACT MSL, REDSTONE BG NANCE

DSA, AMCOM, REDSTONE BG ARMBRUSTER ASSOC DIR TECH, MRDEC REDSTONE, DR. JACOBS

CHF, PREC MUN DIV, ARDEC PICATINNY, MR PEARCY

CHF, SURV DIV, TACOM WARREN, MR SOLTESZ CHICKEN LITTLE JOINT PROGRAM OFFICE DIRECTOR (AF)

DEPUTY DIRECTOR (ARMY)

LETHALITY / VULNERABILITY EFFECTIVENESS

TARGETS, COUNTERMEASURES, & SIGNATURES

CAPTIVE FLIGHT





MISSION AND FUNCTIONS CHICKEN LITTLE





SMART WEAPONS FLIGHT 46 OG / OGN End-to-End Signatures Production & Manageme MDRAF II

DESCRIPTION:

- MISSION: PROVIDE A JOINT CAPABILITY TO SUPPORT DEVELOPMENT AND TESTING OF SMART WEAPON SYSTEMS AND RELATED **TECHNOLOGY.**
- AGENT OF CHOICE FOR TEST AND EVALUATION OF SMART WEAPON SYSTEMS AND RELATED VISION: CHICKEN LITTLE IS THE SUPPORT **TECHNOLOGY BASED ON TECHNICAL** EXCELLENCE, BEST VALUE, AND RESPONSIVENESS.

PROGRAM PHASES:

- **CHARTERED IN FY85**
- 3-Yr effort to evaluate three specific top attack Smart Munitions
 - · Risk reduction
- Update vulnerability models
- CONTINUED AS SERVICE-FUNDED PROGRAM TO SUPPORT SMART WEAPONS DEVELOPERS
 - Enhance technology insertion
 - Provide cost leveraging
- **CURRENTLY IN FOURTH 3-YR PHASE: CHICKEN** LITTLE IV, FY96-FY98

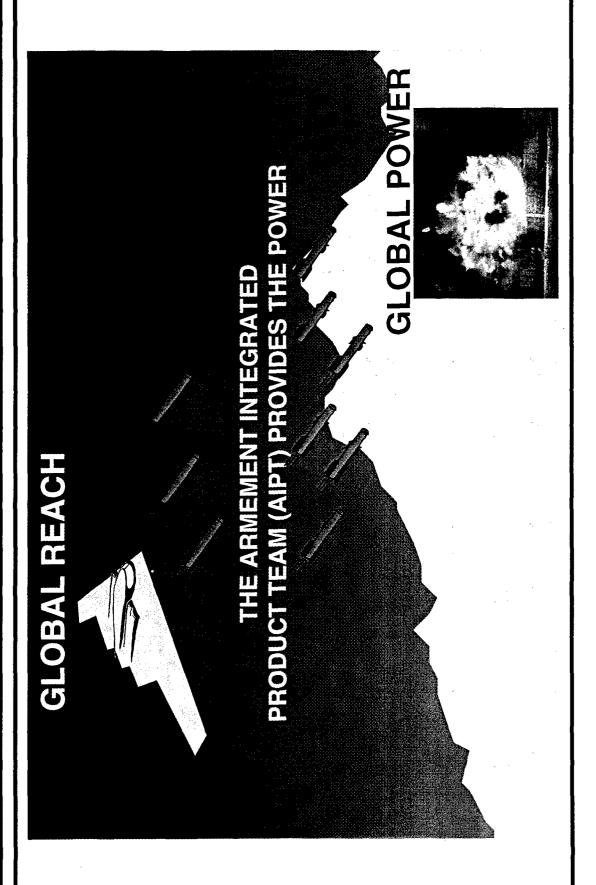
REQUIREMENTS:

- PMD: PMD 5051(12)/PE64604F AF/ARMY MOA **EVALUATE SMART MUNITIONS AND RELATED** TECHNOLOGY
- **ASSESS PERFORMANCE OF SMART/BRILLIANT** SEEKER/SENSOR AND WARHEAR CONCEPTS
- **EVALUATE EMERGING SYSTEM TECHNOLOGIES**
- **WEAPON CONCEPTS ON TARGET ENGAGEMENTS DETERMINE EFFECTIVENESS OF ADVANCED**
 - **UPDATE TARGET VULNERABILITY AND SEEKER** MODELS
- INCREASE TECHNOLOGY INSERTION ACTIVITIES SUPPORT BLUE VEHICLE DEVELOPMENT



U.S.A.F AN EMERGING CONCEPT OF MATERIEL









SENSOR FUZED WEAPON



Seeker / Sensor

Passive Infrared (IR)

Warhead

Explosively Formed Penetrator (EFP)

Target Set
Mobile Reinforced Regimental Advanced Guard (RRAG)

Acquisition Phase Full Rate Production

Fielding

Anti-Armor / Anti-Materiel

Smart-submunition cluster bomb



WIND CORRECTED MUNITIONS **DISPONSER (WCMD)**





Seeker / Sensor

Global Positioning System / Inertial Navigation System (GPS / INS)

Warhead

Tailkit for Combined Effects Munition (CEM), Gator, Sensor Fused Weapon (SFW)

Target Set

Various

Acquisition Phase

Low Rate Initial Production (LRIP) - FY98

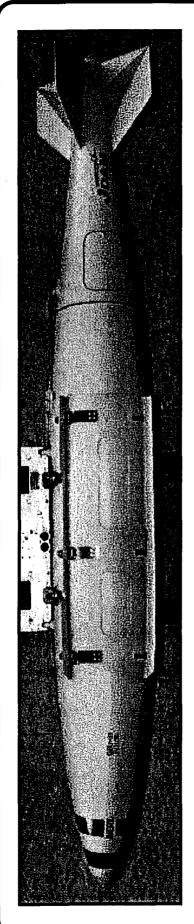
Fielding

FY90



JOINT DIRECT ATTACK MUNITION



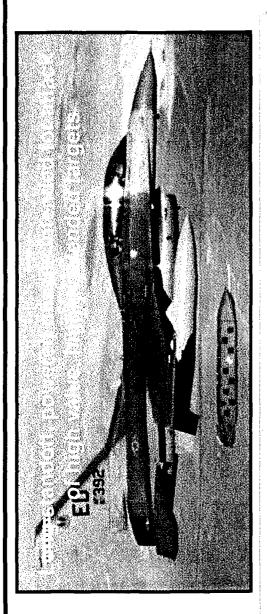


- Seeker / Sensor
- GPS / INS
 Warhead
 Kit for BLU-109, MK-83,
 MK-84
 - **Target Set** Fixed
- Acquisition Phase LRIP FY98
 - **Fielding** FY00



STANDOFF MISSILE (JASSM) JOINT AIR-TO-SURFACE





Seeker / Sensor

Classified

Warhead

Various

Target Set

Fixed and High value Mobile

Acquisition Phase Preliminary Design / Readiness Review (PDRR)

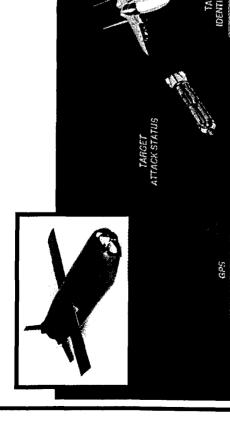
Fielding FY01 +



LOW-COST ANTI-ARMOR SUBMUNITION (LOCAAS)



destruction of anti-materiel targets: armor, trucks, SSM, etc. Powered submunition intended for large footprint search and



Joint USAF / Army Development

Seeker / Sensor
Ladar with Automatic Target
Recognition

Warhead

EFP / multi-fragment

Target Set
Mobile

Acquisition Phase

Laboratory Program

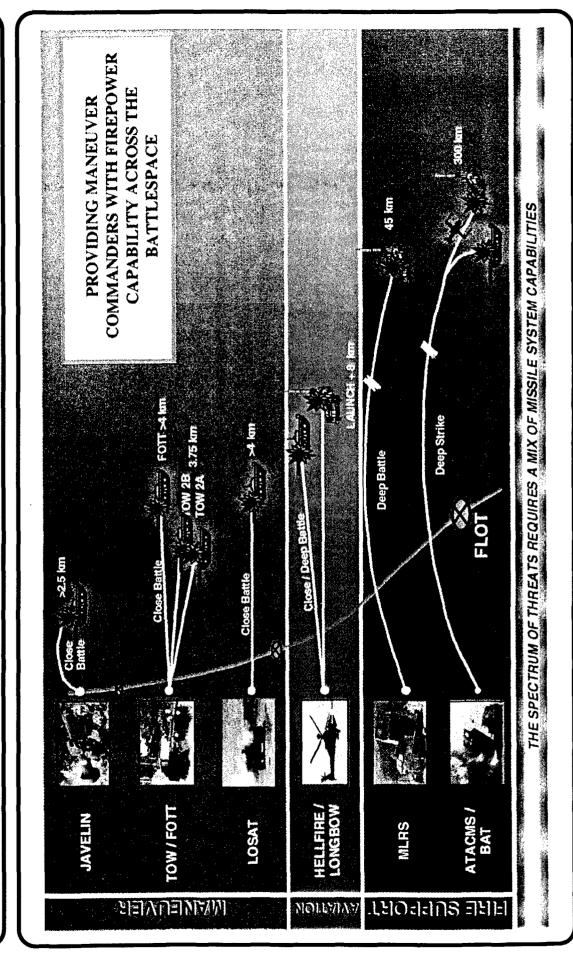
Fielding Unknown

5



TOTAL ARMY SOLUTION







JAVELIN



Seeker / Sensor

Imaging IR 64 x 64 Hg-Cd-Te

Warhead

Tandem Shaped Charge W/H with Precursor

Target SetTanks, APCs, Bunker Targets,
Hovering Helos

Acquisition Phase Full Rate Production

Fielding June, 1996





TUBE-LAUNCHED OPTICALLY-TRACKED WIRE-GUIDED (TOW-2B) FOLLOW-ON TO TOW (FOTT)



Seeker / Sensor

TOW-2B Laser, Magnetic, Impact TBD FOTT

Warhead

TOW 2B MISSILE
GUIDED MISSILE, SURFACE ATTACK: BGM 71F

TOW-2B Two EFPS TBD FOTT

Target Set TOW-2B Tanks and APCs FOTT

Tanks and APCs, Secondary Helicopters

Acquisition Phase

FOW-2B Sustainment

TBD FOTT

Fielding

1991

TBD FOTT



ANTI-TANK (LOSAT) LINE-OF-SIGHT



- Seeker / Sensor
- 2nd Gen FLIR in Fire Unit
- Warhead
 Heavy Metal Long Rod Kinetic
 Penetrator
- **Target Set**
- Heavy Armored Vehicles and Bunkers
- Acquisition Phase
 Advanced Concept
 Technology Demonstrator
 (ACTD)

Fielding FY03-04



HELLFIRE / LONGBOW



Seeker / Sensor Ka-Band MMW

Warhead
Tandem W/H with Precursor
and Shaped Change

Target Set
Tanks, ADUs, APCs
Acquisition Phase
Production
Fielding

IOC - Oct 98





MULTIPLE LAUNCH ROCKET SYSTEM (MLRS)



Seeker / Sensor

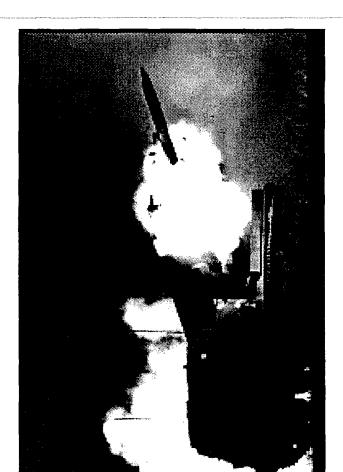
∢ Z Warhead N/A

Target Set

Counterbattery, Air Defense, Logistics Sites Command and Control Sites

Acquisition Phase M270 - Production M270A1 - CRIP

Fielding M270 - Complete M270A1 - FY00





ATACMS / BAT





BAT Imaging IR (I²R) Seeker P³I MMW and I2R Seeker

Warhead

BAT Precursor / Main Charge P³l Improved Conventional Shaped Charge

Target Set

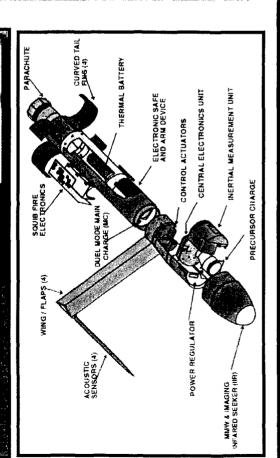
BAT Tanks, BMPs, Self-Propelled Howitzers P³I Armor, SSMTELS, Hot or Cold

Acquisition Phase

BAT EMD P3I DEMVAL

Fielding

BAT FY01 P3| FY03 / FY04





WIDE AREA MUNITION (WAM)





Warhead EFP

Armor and Light Armor

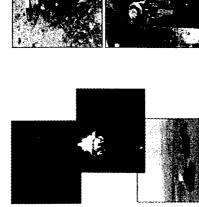
• Acquisition Phase
Low Rate Initial Production
(LRIP)
Fielding
FY98

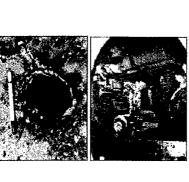


SENSE AND DESTROY ARMOR (SADARM)









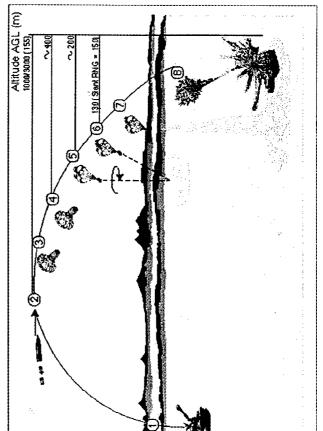


Warhead EFP

Target Set
Self-Propelled Howitzers

Acquisition PhaseLow Rate Initial Production

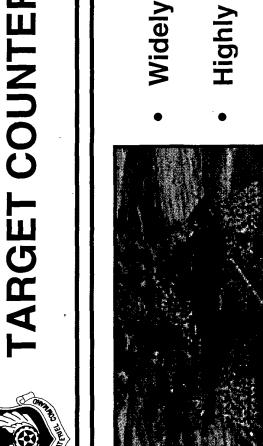
(LRIP) **Fielding** FY99



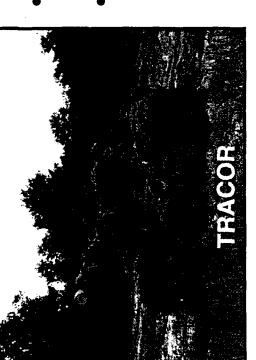


TARGET COUNTERMEASURES





- Widely Proliferated
- Highly Effective
- Low-Cost
- Significantly Reduced Delta-T
- Significantly Reduced RF Signatures products. Other, more advanced CM These are open-source, commercial almost certainly in nationals,



classified programs



TECHNOLOGY DIRECTION



ther Resolution Sensors

Sitivity

() () essing

a get Recognition

HSOr Fusion

Required to Defeat CMs



SUMMARY



- Significant Smart Weapon Capability in Inventory and Planned for Future
- New CM Technologies Driving Seeker / Sensor Designs
- Programs Keeping Pace with Threat Army and Air Force Munitions

Deputy,
Assistant Secretary of the Army
Logistics





- A Full Spectrum Force

Support to the Nation



Fight and Win







Deter Aggression
 Prevent Conflict

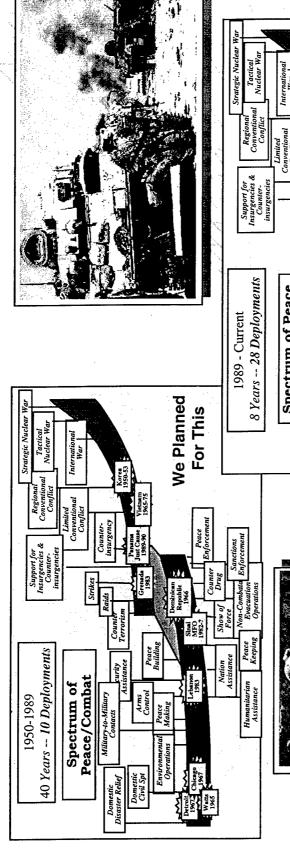
/ Peacetime Engagement

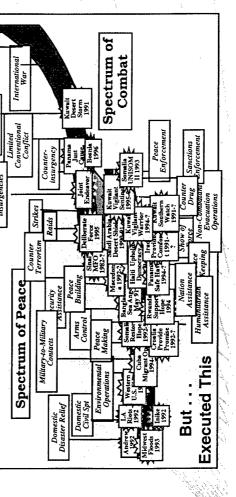


To Protect and Further National Interests



THE NEW ENVIRONMENT





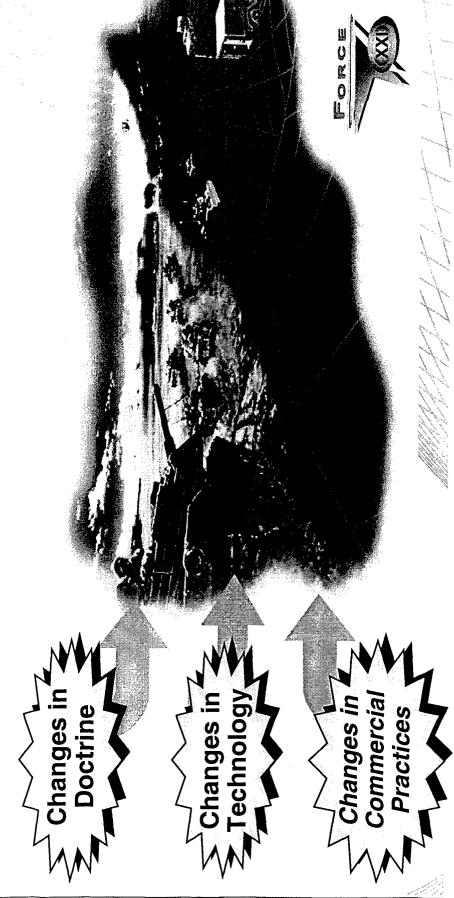
Army Deployments have dramatically increased While the Cold War threat is diminished,

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ARMY XXI

- Modernization through Sustainment Reform



You can't build a STAR WARS Army with COLD WAR Thinking



REVOLUTION IN MILITARY LOGISTICS - Already Underway -

"You cannot have a Revolution in Military Affairs without having a Revolution in Military Logistics" General Dennis J. Reimer Chief of Staff United States Army



- * Trade Mass for Velocity
- * Change Business Practices
- * Achieve Smaller Footprint * Support to the Soldier . . .
- Right Stuff,

Right Place, Right Time

Revolution In Military Logistics



"A Revolution in Military Logistics, Leveraging Technology to Fuse New Concepts, Information, and Logistics Systems, Reshaping the Way We Project and Sustain America's Army in the 21st

Century"

Conf. G. Colline

Helphoner General GS

FOBERT M. WALKER
Assistant Secretary of the Amy
(Installations, Logistics,
and Environment)

80

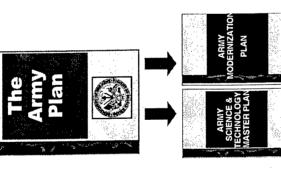


FOCUSING THE REVOLUTION IN MILITARY LOGISTICS









Dominate Battlefield Awareness

Conduct Peacetime Ops

Maintain Force Readiness

Generate the Force

Deploy the Force

Perform Other Missions

Protect the Force

Promote Regional Security

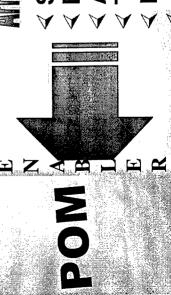
- Win the Land Battle

Sustain the Force











Total Asset Visibility

Adequate Logistics Footprint A Rapid Force Projection



& Simulation Modeling,

50 | |



CORPORATE EXAMPLE - ART OF POSSIBLE

The Private Sector and the Army are Learning from Each Other...

* What We've Learned About Automation and Communication:

Information treated as a strategic asset.

(Wiseperson Conference: Log = Info)

Rapid acceptance of networks and the INTERNET technology.

Speed of development to fielding is 5 months.

L.L.Bean

* Art of the Possible

On-line ordering, electronic catalogs, tiered pricing

GSA Advantage, Day Timers, LL Bean, Lands End

Satellite links stores, corporate, vendors, and delivery agents . . . *Toys-R-Us, Wal-Mart*

Satellite connectivity, corporate HQ and field . . . Schneider Trucking

Networking between retail outlets and corporate databases ... *GM, Ford* Worldwide tracking of on-line asset visibility . . . FedEx Delivery of major components worldwide with

maintenance support ... Caterpillar ... "Buy Our Log"

CATERPILLAR®

istribution-Based Velocity in a System



Customer











THREE DOMAINS OF THE RML

Technology Application And Acquisition

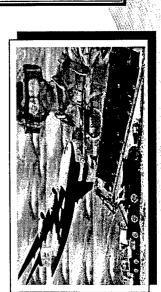
- → Leverage National Technology Base
- → Rapidly Identify and Exploit Emerging Technology
- → Rapid Acquisition
- → Life Cycle Support

Domains

Force Projection

- → Rapidly Project CONUS Based Forces with Support Structure
- → Lighter and Smaller Sustainment Requirements
- → Less Logistics
 > Infrastructure

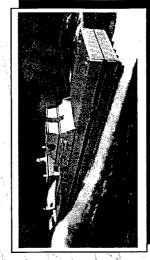




Force Sustainment

- → Maintain Peacetime Readiness
- → CONUS-Based, Agile and Responsive
- → Velocity Provided in a Distribution-Based Logistics System







CHANGING HOW WE PERFORM LOGISTICS

Through Business Processes Change

Through Organizational Change

➤ Through C4I System Change

▼ Through Hardware Enablers





Within the Three RML Domains and it's Six Tenets





- Business Process Change THE RML ROAD AHEAD

PRESENT

FUTURE

Virtual S Inventory



Single Stock Fund

National Mgmt

Technology Insertion

for Maint. National NS. Regional NSI SM

Cycle Support Contract Life Prime Vendor

Support

Contractor

Support

Factory To Foxhole

Life Cycle Cost Management

TOSA,

Best Value

Partnering

Acquisition Reform

Vendor Held **Direct Vendor Delivery**

**Reduced Cycle Times

Velocity Management

Inventory

Distribution Based

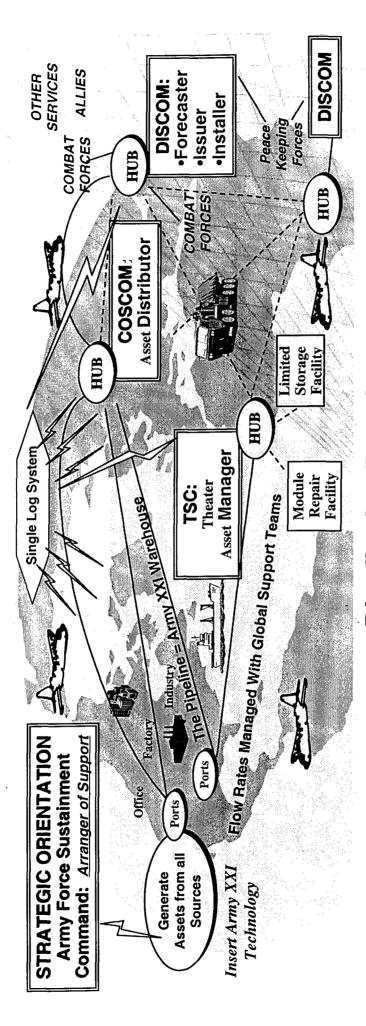
, Management

Fleet

Logistics



DISTRIBUTION BASED



Distribution Based:

Global Connectivity

- Single CSS System
- Commo and Organization Seamless Automation,

Four Supply Types: Bulk

OST in Hours

Velocity

- Common Source Data Anticipatory Logistics
- RSO&
- Quick Combat Power Build-Up Integration
 - Optimized CSS Flow

Theater Redesign

- Reengineered Deployed CSS
 - Effective Throughput
- Hub and Spoke System
- Theater/Area Distribution Mgt by Combining Elements of the Theater Support Striving for 2 Maintenance Levels Supplies, Ammo, Fuel, and Blood

Limited OCONUS Buffer Stocks

Financial and Log System



PARTNERS

- On the Battlefield -

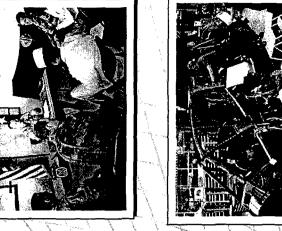
We've Always had Contractors On Our Nation's Battlefields Will only grow as we move into the 21st Century

- Fills the Gap Between Capabilities and Requirements
- Augments Services, Transportation, Maintenance, Theater Logistics Infrastructure, Wholesale Logistics functions



- Knowledge of Life Cycle Acquisition Strategy
 - Knowledge of Sophisticated Weapon Systems
 - Modular, Expansible, Deployable
- Split Based Operations
- **Executes within Existing Early Entry Module Force Structure** Constraints
 - Enhances Training & ability to Transition

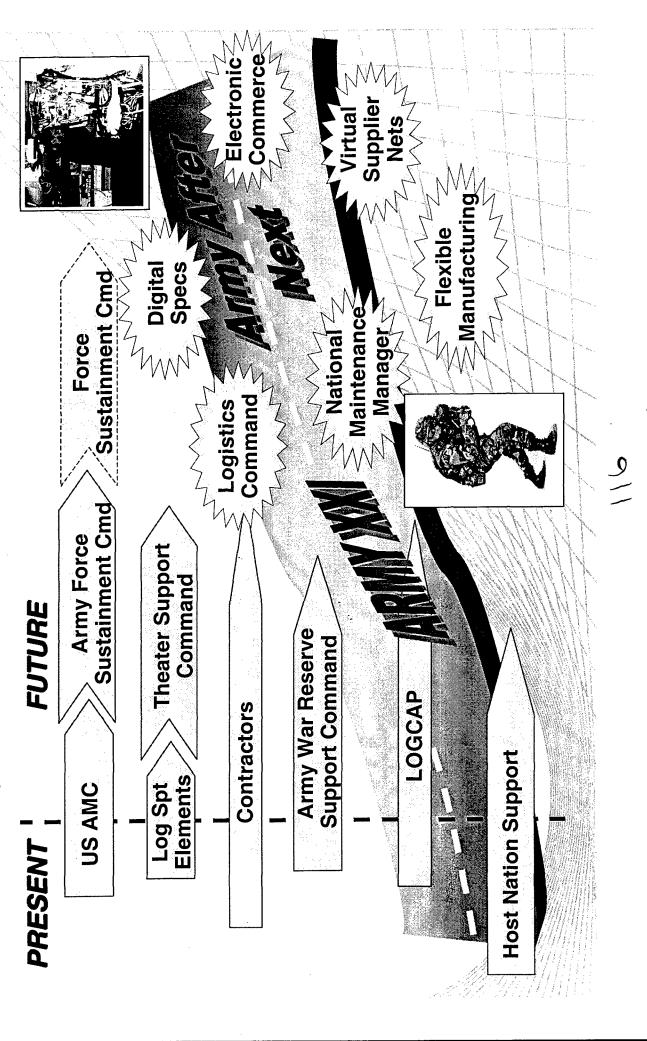








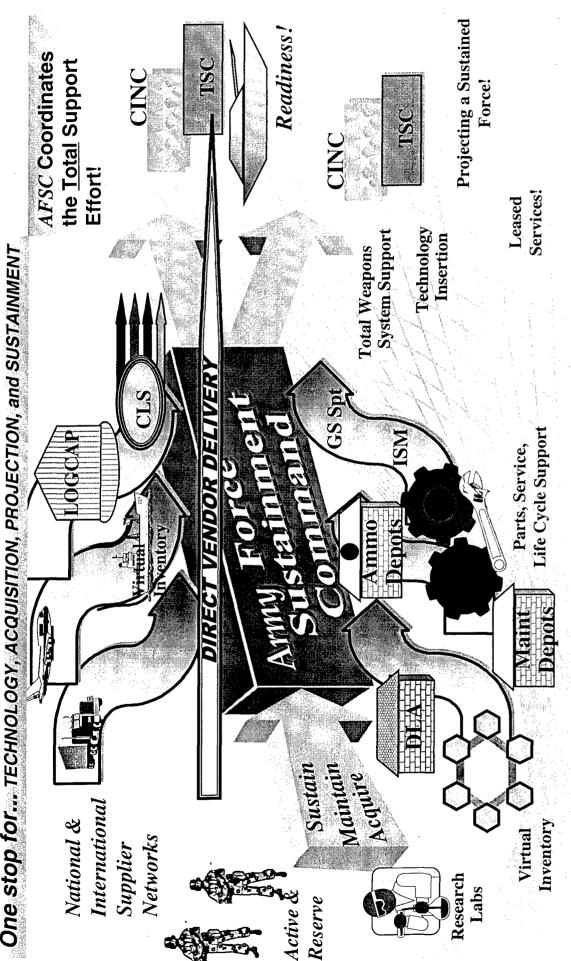
THE RML ROAD AHEAD Organizational Change -





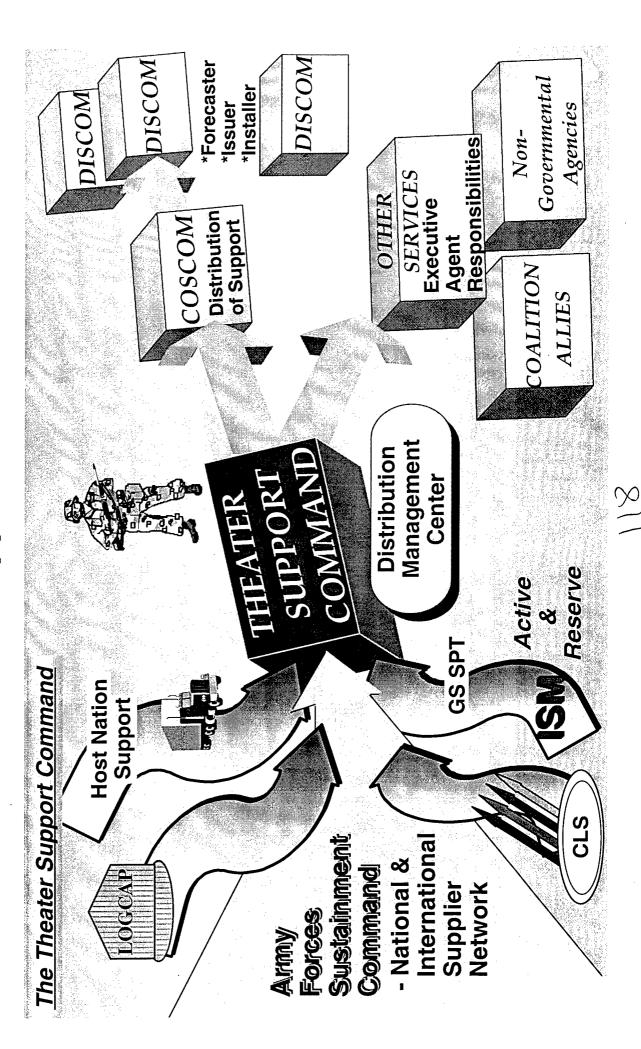
POWER PROJECTION LOGISTICS - Force Sustainment Command

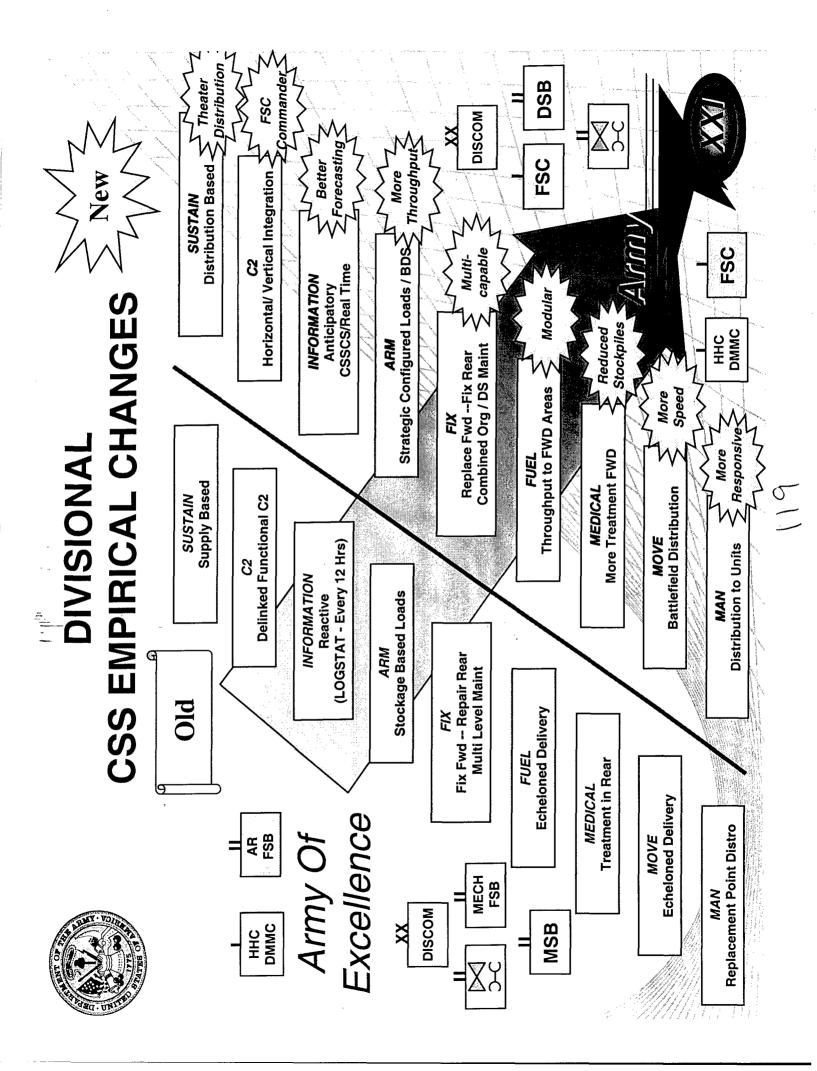
The Army Force Sustainment Command





POWER PROJECTION LOGISTICS - Theater Support Command -







THE RML ROAD AHEAD - Systems Change -

PRESENT |

FUTURE

Combat Service Support Control System (CSSCS)

Assured

cations

Global Combat Support System- Army (GCSS-A)

Total Asset Visibility

Real Time Visibility

TC AIMS II

TC ACCIS

Single Seamless

Log/Fin System

> Leverage COT

"Best in Class"

JTAV

ATAV

021



LOGISTICS AUTOMATION - Where We're Going

Separate Approach From this...

ULLS-G/A/S4 **SAMS-1/2** SARSS-0

SPBS-R SAAS ILAP

ogistics. Tactical



CCSS SDS



GCSS

S-AIMS II N L U

Operations Wholesale

Joint Operations

Integrated To this... System

Essential

Modernization for Logistics & Efficiency

> GCSS-Army

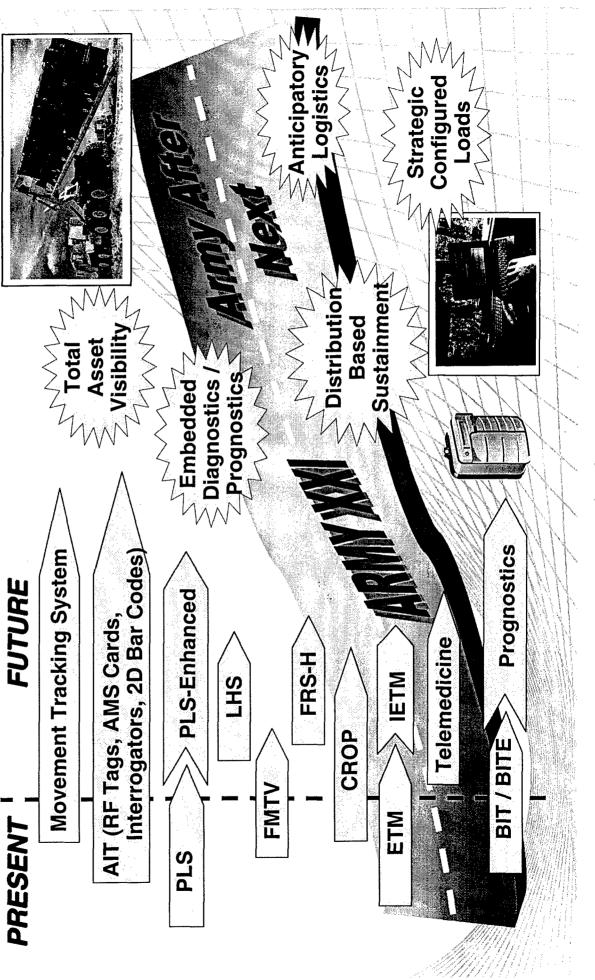
Formerly Called ICS-3

Support System - Army Global Combat

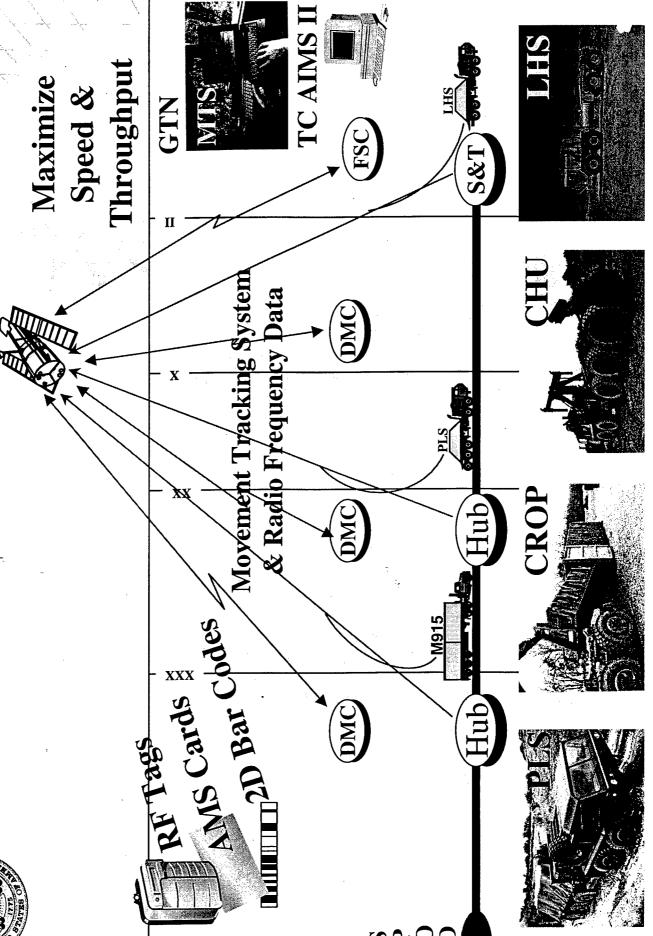
- Modernizes and replaces existing
- STAMISS goal is one seamless system Army portion of GCSS; tiered approach
 - Program oversight by GEN Hartzog
- **Eully funded to field current functionality** by FY03; working to accelerate in POM
- Finalizing Systems & Data Architecture just completed Software Reqts Review
- Begin testing initial releases at Ft Hood in Jul 98
- Fielding plan being coordinated (includes regional focus w/simul fielding to RC)



THE RML ROAD AHEAD - Hardware Enablers -



DISTRIBUTION ENABLERS





500



CHANGING THE POLICY

Embedded Diagnostics/Prognostics

OASARDA **OSA**

Synchronization of efforts between **ARSTAFF & SECRETARIAT**

VCSA WW (ODCSTOC)

to take advantage

of commonality

SIGNED 30 APR 98

TO: All PMs, PEOs, Acquisition and Combat Developers

coordinate acquisition

PMs & PEOs will

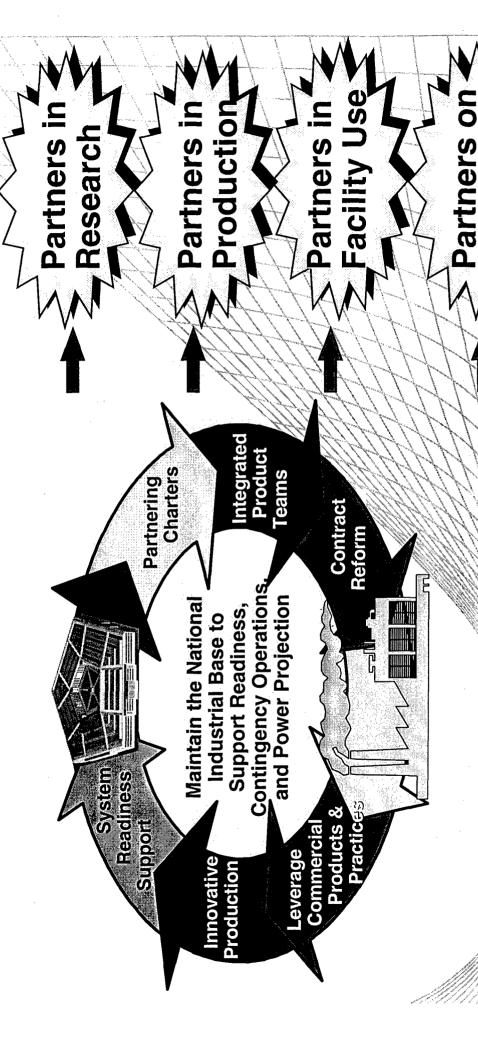
plan with PM-TMDE

will coordinate Plan TSMs & Cbt Dvlp'rs with PM-TMDE

VCSA Bottom Line:

embedded diagnostics. Our policy will favor fewer "We will not field systems or retrofit without more capable systems"

PARTNERS WITH INDUSTRY



,Battlefield



WHAT I WOULD LEAVE YOU WITH ...

A Weak Industry = A Weak Army

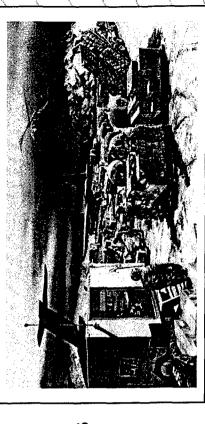
The Revolution in Military Logistics is Underway. Look for increased ...

- Partnering

- Outsourcing

- Commercial Business Practices

Contractors on the Battlefield



Technology Offers Us Fast, Cheap Transportation, Communications, and Information . . . we plan to exploit it

We're Changing Processes and Mindsets Entrenched for 40 Years

Fundamental Values and a Steady Focus on Quality Soldiers, World Class Equipment, and Relevant Doctrine Will Remain Our Bedrock

Will Need Your Help to "Get It Right"

=

Army After Next

An Industry Perspective

MG Frank P. Ragano (Ret'd.)

June 23, 1998

A Member of the Daimler-Benz Group

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Date: 06/10/98



AAN - "It's the Right Thing to Do!"

- Unfolding technologies leading to unprecedented warfighting capabilities
- RMA -"Revolution in Military Affairs" already in progress
- Future adversaries will employ advanced weaponry and communication systems

Developing and fielding superior technologies envisioned for AAN - Essential in maintaining global leadership



Revolution ...

- Relative to 1998, the Army of 2030-2040 will surely make the Revolution in Military Affairs a reality
- "Revolutionary" rhetoric essential to inspire and embrace the required level of thinking



. .. Or Evolution?

- AAN concepts will be taking shape over the next decade or more
- Certain new technology developments cannot be foreseen, but will profoundly affect the future force
- Budget limitations will continue to impede modernization

Transitioning from Army XXI to AAN - a process . .

- Evolving the Army to a 21st century force
- No watershed line of distinction

A Member of the Daimler-Benz Group

Date: 06/10/98



Greatest Adversary to AAN: Eroding Budget

Don't count on Congress to cooperate - current funding is insufficient

- Precision Strike systems already delayed
- \$2.6B shortfall in modernization accounts over POM
- Terminating production programs early (Abrams, Longbow)
- FOTT cancelled
- Additional annual reprogramming, to fund much larger Operations & Support deficit



AAN - 2020? 2030? 2040?

Incompatible:

AAN/RMA requirements vs. modernization funding shortfall

Tradeoff:

Relax readiness standards to fund modernization?

Practical Reality:

Readiness takes precedence, so AAN will slide to the right....



The Industrial/Conventional Ammo Base Has Sustained us Thus Far

- Sea change = risk
- Some elements will falter, requiring a safety net until alternatives are developed
- Some Army operations will remain manpower intensive
- Less adaptable to ultra-high tech approaches
- Extent of budget-driven schedule delay cannot be predicted

Do not disable the industrial base until AAN is in

place and demonstrated capable



AAN - K.I.S.S.

- Lessons from commercial software industry:
- Very powerful, elegant technical solutions, but
- User-friendly is PARAMOUNT!!
- Consider soldier needs, limitations, training requirements
- Ask soldiers what it takes to operate and sustain equipment in the field



AAN - Partner with Industry

- Army/Industry partnership moving in the right direction as we enter 21st century
- Success in acquisition reform can be extended into other areas, including AAN concept development
- Army efforts to disseminate AAN information are positive
- Internet
- Various industry forums
- Institutionalize industry as fundamental participant in AAN planning process



AAN - Sell Better!

- Industry works hard to develop and produce the best equipment for the Army, but
- We have to SELL first, in order to get the chance . . .
- Take lesson from industry Sell the Army budget better
- Essential to increase funding to support readiness and modernization
- Leverage on QDR, Joint Vision 2010, National Defense Panel
- Conventional land power is core capability for 21st century global scenario

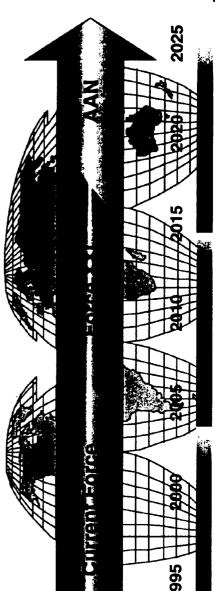
AAN - "Takeaway"

- It's the Right Thing to Do!
- Emergence of AAN likely to be an evolutionary process
- Preserve the Industrial Base during transition
- Keep it simple/practical for soldier in the field
- Partner with industry throughout the process
- Sell the Army budget better increased Army topline essential to AAN success!



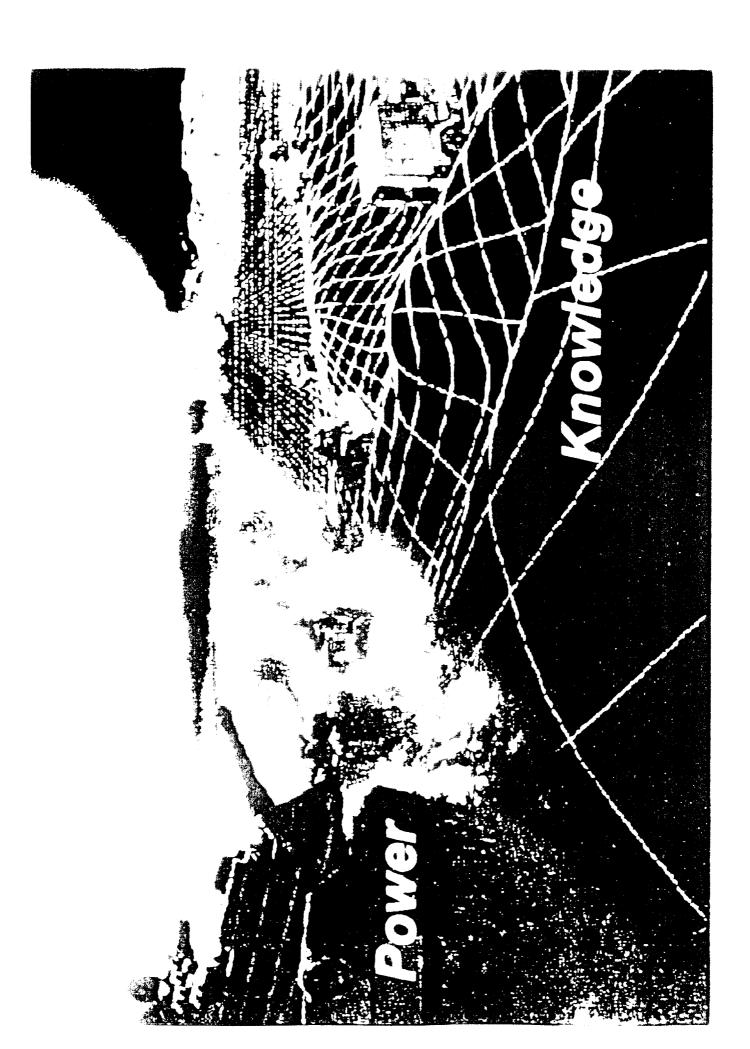
LOOKING INTO THE FUTURE

- Need to balance Knowledge (digitization) and Power (lethality)
- Today we are heavily invested in knowledge
- Present lethality budget inadequate
- Improved lethality is required for:
- Army of Excellence..... (today)
- (circa 2010) Force XXI
- Army After Next.......(circa 2025)
- Investment in conventional ammunition is required
- Product Improvements that support both Today's Army & AAN is essential

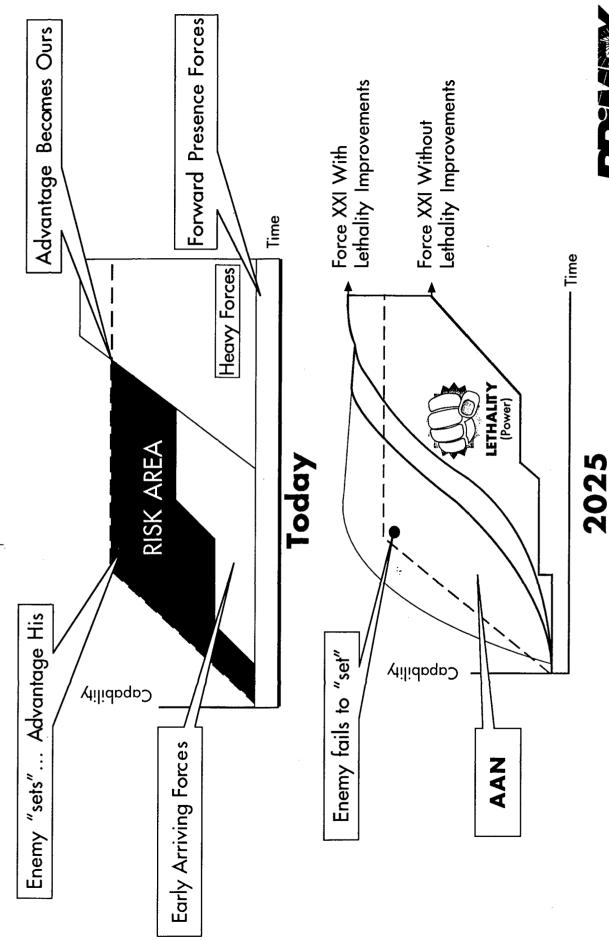




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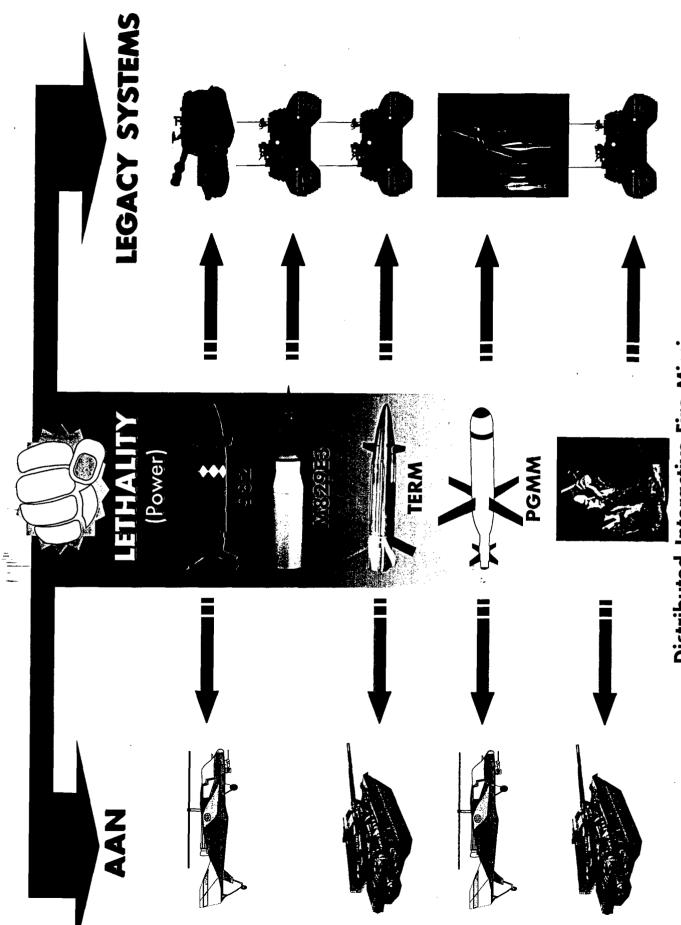


LETHALITY IS CRITICAL TO FORCE XXI & AAN





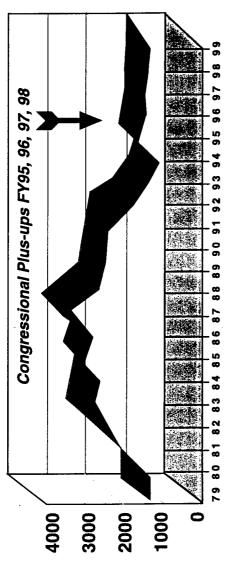
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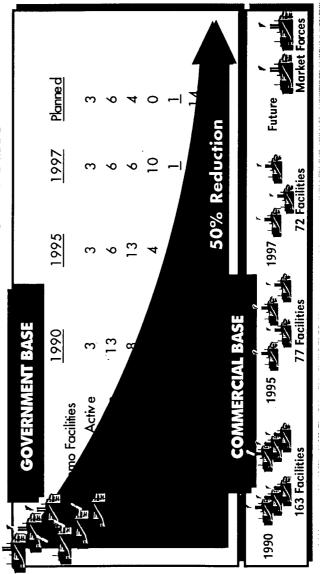


AMMO PRODUCTION CAPABILITY IS DISAPPEARI

PROCUREMENT TRENDS ARE DOWNWARD



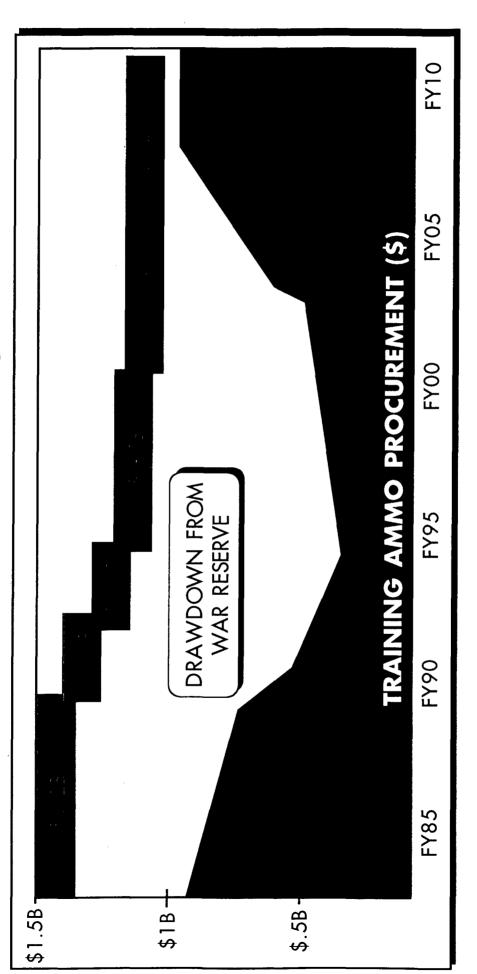
AMMO FACILITIES ARE SHRINKING





73

FUTURE PROCUREMENTS PRIMARY TRAINING



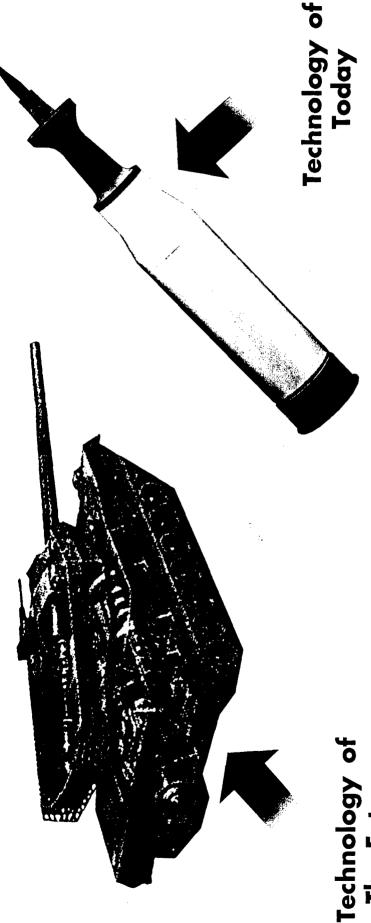
How Do We Procure Modern Ammo For The Future Army



ブケー

SUMMARY

Success of Army After Next Depends on Improvements to Lethality of Force XXI Systems



The Future

Army After Next ~ 10% - 20% of the Force Force XXI ~ the Remainder





Requirements through 2010



JSA ARMOR CENTER

TRADOC Systems Manager's Office Abrams Tank (Guns/Ammo/Armor) WALT MEINSHAUSEN

30,31,9

1997 Gun & Ammunition ICT

- main gun fires at extended ranges in all visibility conditions Improved ability to acquire, engage and defeat targets with
- Affirmed KE as Primary Anti-Tank Round
- Develop Smart Weapons for Extended Range
- Investigate APERS Utility
- Multi-Purpose Anti-Tank (MPAT) Training Rounds Develop Long Range Kinetic Energy (LRKE) &
- Prepare Tank Ammo ORD to replace AEI ORD
- Change multiple round development to one round/time

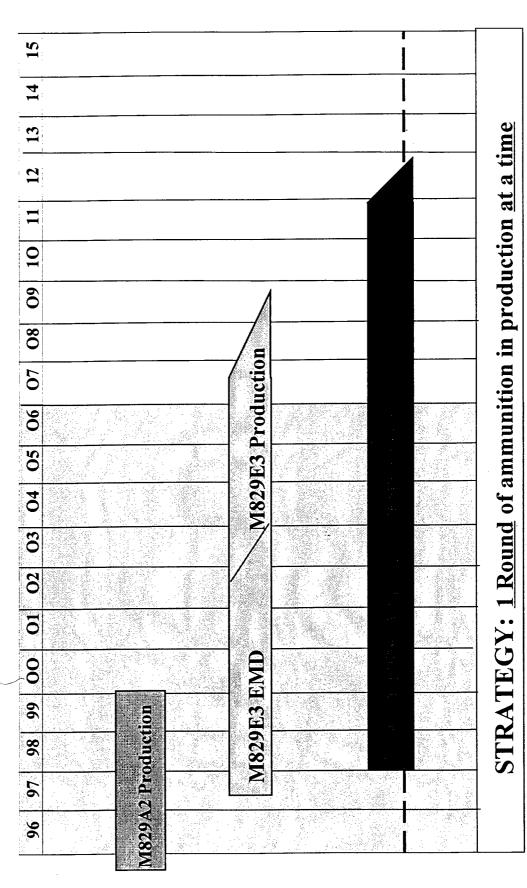
Continued technology investment for lethality overmatch is a priority





SOLDIERS Are Our Credentials!

Tank Ammunition Strategy





Threat Considerations

- Standoff Munitions
- ▶ Current Munitions (AT-11, AT-5: 5KM)

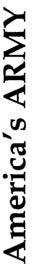
(KORNET: 5.5KM)

- ◆Future Munitions (up to 12 KM)
- Active Protective Measures
- ▶ ERA 2 available now, 3&4 w/i 2 years
- ►APS (DROZD, Arena, Shtora-1) available now
- Conventional munitions effectiveness will decrease



The Armor Center Believes That:

- Situational Awareness, and New Doctrine & Organizational Designs The Combination of Precision Guided Munitions, Blue & Red will Significantly Impact Future Armored Vehicle Designs
- therefore continued improvement of conventional ammunition & The Requirement for Line-of-Sight close Combat is Enduring, guns is essential
- A Beyond Line-of-Sight Precision Fire Capability for the Tank is a Natural Consequence of the Expanded Non-Linear Battlespace Concept

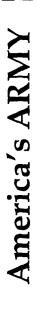






Digitized Battlefield

- Real-time red situational awareness (SA) & digital connectivity enables sensor-to-shooter linkage
- Exponentially more effective Deep Fires (Indirect/fixed wing/attack helicopter)
- Expanded battlespace for brigade & division commanders
- Real-time red & blue SA for close combat units
- Accelerated tempo of operations
- Observe Mass forces & fires Disperse
- Wider dispersion of forces; Greater depth?
- Opportunity to expand the Battalion/Task Force battlespace

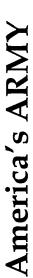






Tank PGM History

- 1960-1970s The M551 Sheridan & M60A2 with a Shillelagh Missile
- 1981- Armor Center engages in top attack & extended range munitions studies (Rocket Assisted Kinetic Energy - RAKE)
- 1984- Armaments Enhancement Initiatives begin: RAKE, STAFF
- 1987-1993- XROD program conducted by DARPA
- 1994-1997- Congressional plus-ups add over \$48M to PM TMAS for top attack KE munitions development (\$15M for FY98)
- 1996- Army Science Board endorses use of smart tank munitions.
- 1997- Annex G (Tank Extended Range Munition) of Draft Tank Ammunition
- 1997 Approved FY98 Science & Technology Objective (Extended Range Munition FY98-02)
- 1998 TRADOC ICT: Tank Extended Range Munition





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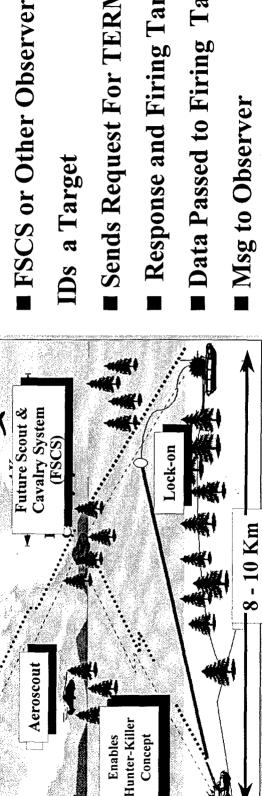
Tank Extended Range Munition

O&O Concept

UAV

CONCEPT

TERM



TERM provides the TF CDR:

- Organic
- Responsive
- Precision

FIRES

Response and Firing Tank ID ■ Data Passed to Firing Tank | Sends Request For TERM ■ Msg to Observer

■ TERM Fired

■ BDA or Repeat

Draft ORD

- Beyond Line of Sight/Line of Sight
- Range: 8-10 Kilometers
- Designated Target and/or Fire and Forget
- Defeats 2005-2015 Threat
- Active/Passive Countermeasure Resistant
- Hard/Soft Kill APS Resistant
- Unit Cost ~ \$ 25,000



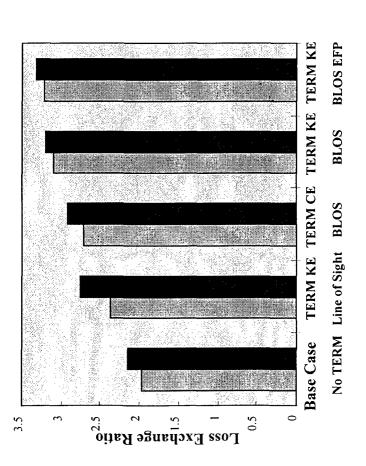
Recent Analyses

- ARL Phase I Front-end Analysis 1996 TRAC-WSMR
- "Phase II" Front-end Analysis 1996 DFD
- FXXI Armor Battalion Redesign CEP 1997 MMBL
- Phase III 1998 TRAC-WSMR





Phase I Front-End Analysis ARL/ TRAC-WSMR



Phase I & II Analysis

Phase II Front-End Analysis DFD

Phase I& II Conclusions

- payoff in increased lethality at extended TERM candidates have an operational ranges over the base case.
- reducing tank losses by as much as half. TERM increases force survivability
- APS reduced TERM effectiveness for slower-moving candidate munitions.
- TERM LOS/BLOS combined capability proved to be more effective than LOS

America's ARMY

■ LER SWA

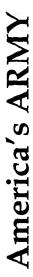
LER NEA





What Can We Conclude From Analyses to Date?

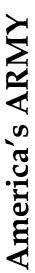
- TERM, M1A2, and FSCS significantly increase the combat power of the Battalion Task Force
- control an extended battlespace and set the conditions for TERM effectively enables the Battalion/TF Commander to the direct-fire fight
- I TERM will free helicopters and artillery to fight deeper/sustain the deep fight longer
- Additional experimentation is required
- ▶ Request for fires process/management
- ◆ Tactics, Techniques & Procedures
- **♦** Cost effectiveness





TERM ICT Charter

- Prepare detailed Operational Concept
- Conduct focused analytical effort with TRAC
- Refine TERM Annex to Tank Ammunition ORD
- Develop and execute strategy to Milestone I or I/II
- Smooth transition to TERM IPT
- Conduct information and decision briefings as required



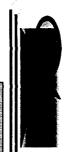
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TERM & The Tank Emerging Implications

- Design, and Doctrine will Blur the Traditional Paradigm of Distinct PGMs, Situational Awareness / Digitization, Future Organizational Direct and Indirect Fire Systems and Roles
- Tank Launched PGMs Have the Potential to Dramatically Change the Character of the Close Fight
- A Mix of Main Gun, direct & Indirect PGMs, and DEW will Most Likely be Required for the Close Fight
- A Mix of Survivability Measures With Significantly Less Reliance on Heavy Armor will Result in Lower Weight, Faster Speed, Lower Logistical Demands, and Faster Strategic / Operational **Deployability**





What about the Gun?

- a the Electro-Thermal Chemical (ETC) gun development as Continued Threat Improvements require development of Risk Mitigator for the Abrams Tank
- Maintain continued lethality overmatch for conventional guns at normal combat ranges (L55?)
- New Medium Caliber Cannon is needed
- ◆ Threat BMP's UAV's Helo's, Troops
- 25mm has reached its potential
- Reliability
- Range
- Killing Power/Pkh
- 35 mm Chain Gun More of the Same?
- Only other new R&D > CTW (35,40,45,50 mm) ETC, EM Medium gun?

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FUTURE SCOUT & CAVALRY SYSTEM (FSCS) LETHALITY

KEY PERFORMANCE PARAMETER



•MEDIUM GUN (FOR SELF DEFENSE)

-NON CREW SERVED

-DEFEAT THE PRIMARY LAV THREAT

-GROWTH POTENTIAL

-ARMOR PIERCING & GP ROUNDS

SECONDARY ARMAMENT

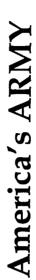
"THE FSCS/TRACER VEHICLE IS REQUIRED TO MOUNT WEAPON SYSTEMS THAT PROVIDE A SELF DEFENSE CAPABILITY WITH GROWTH POTENTIAL THROUGH THE LIFE OF THE VEHICLE."





Conclusions

- make continued US gun and ammunition development but reduced funding requires a strategy adjustment essential to maintain overmatch for legacy systems Threat Developments and technology evolution
- Battalion/Task Force Commanders to leverage digitization Beyond line-of sight Precision Capability will enable for more lethality and improve force survivability
- munitions is enduring but production quantities will be The requirement for line-of-sight close combat (KE)
- New Medium Caliber Cannon is needed





Army Aviation Modernization Mid-Term Requirements





















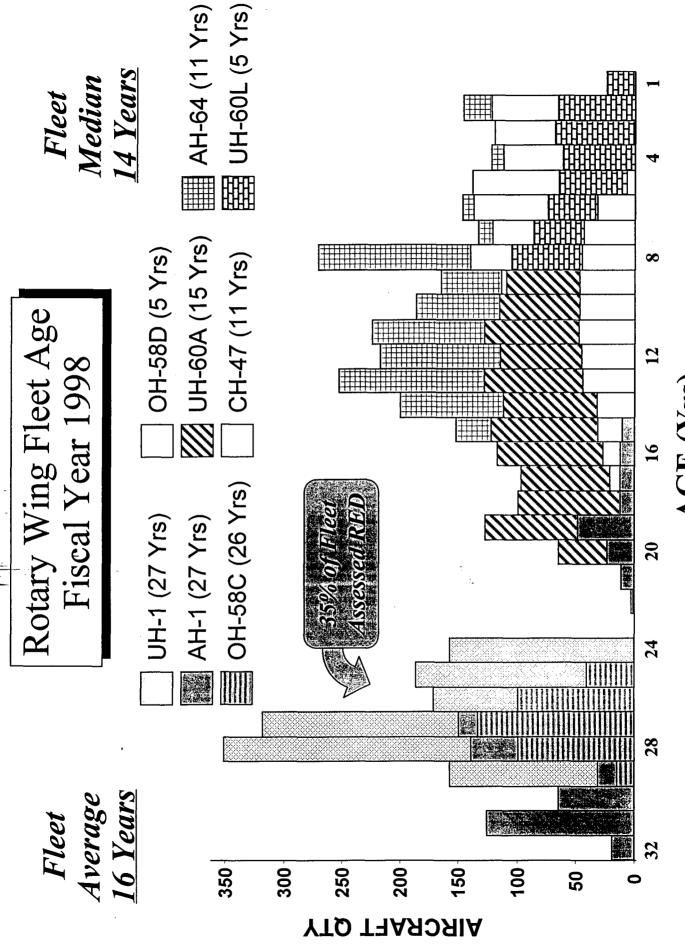






Aviation Modernization Driving Factors

		9 40,010
Near-Term	Mid-Term	Far-Term
FY 1998-2003	FY 2004-2010	FY 2011-2020
Digitized Div by FY00 Digitized Corps by FY04	Fleet Compatibility With Army XXI/Embedded Baffle Command	Average Airframe Age in 2020 CH-47 > 50 AH-64 > 30
Over 500 Obsolete AH-1/OH-58C	FY02: UH-60 Begins	OH-58D > 25 UH-60 > 30
Over 900 UH-1 > 25 Years	ATG Missile Inventory	C-12 > 30 RAH-66 Reaches Half-Life
FY02: CH-47 Begins Turning 40 Years Old	Joint/Combined Arms Training & Simulation	UH-1 Replacement S&T Support for AAN
OH-58D Lacks Range	OH-58D Lacks Range, Speed, Payload & Ballistic Survivability	urvivability
• Air Traffic Control /	Air Traffic Control / Air Traffic Services Modernization	lion
		_
 Maintain Combat Overmatch Capability Affordability / O&S Cost 	ermatch Capability ost	
 Maintain Recapitaliza Joint/Combined Arma 	Maintain Recapitalization Funding to Guard Against Fleet Obsolescence Joint Service Systems / Subsystems Requirements Joint/Combined Arms Training & Simulation Requirements	t Fleet Obsolescence
Joint/Coalition C4I Interoperability	teroperability	



AGE (Yrs)

Note: Special Opns/SEMA not included

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Modernization Objectives

INFORMATION DOMINANCE

DIGITIZE MODERN AIRCRAFT FIX RECON/SECURITY



- Survivable by Design **RAH-66**
- ✓ Superior Targeting
- **Enhanced Performance** & Maneuverability
- Air Combat Capability Low Observable
- ✓ Rapidly Deployable
- ✓ Speed/Range for
 - Deep Opns
- Scout Opns w/AH-64
- Security Opns
- Maintainability (2 Level) Improved Reliability &

Embedded Battle Command

Mission Planning System

Integration

Enhanced C31 (A2C2S)

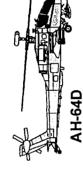
Global Positioning System

- Shipboard Compatible
- Fully Digitized
- ✓ NBC Protection/Detection

✓ Joint Operations

✓ Digitized Aviation Logistics

MAINTAIN ATTACK OVERMATCH



WARRIOR

OH-58D KIOWA



AH-64D

Weather & Obscured ✓ Fight in Adverse Battlefields

09-HW/HD

Threat Stand-off

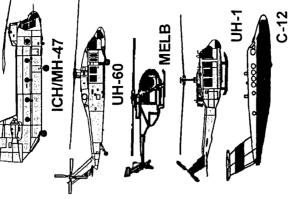
CH/MH-47

✓ Joint Service Interoperable

✓ Non-Line of Sight Comm

- / Increased Survivability Fire & Forget Missile
- / Rapid Target Servicing Improved Reliability
- Crew Workload Improvements
- C3I, Improved Nav /Fully Digitized

MEDEVAC, & FIXED CARGO, UTILITY, RECAPITALIZE WING FLEETS



- ✓ Address O&S Cost Issues
- / Improve RAM
- Maintain Safety
- **Essential Operational** Improvements

DEVELOP ESSENTIAL SCIENCE & TECHNOLOGY

- Crew Associate/Cognitive Decision Aid
 - Manned/Unmanned Integration
- Advanced Integrated Cockpit, Sensor Fusion, Virtual Displays
 - Advanced Platform Technologies
- Future Missile Technologies

- Joint Transport Rotorcraft
- Future Utility Rotorcraft
- · Multi-Role / Mission Adaptable Air Vehicle
 - Hellfire III
- Full Spectrum Threat Protection

Objective Force Requirements

CH-47 ICH	JTR	112	78	48	120	06	448	
	009-Hn	117	75	09	105	30	387	•
/ T09-H Ω	ПОМОЭ-НО	301	179	261	360	335	1436	()
		Force Package 1	Force Package 2	Force Package 3	Force Package 4	Float, Attrition, TDA & Training	Total Requirements	
Light	Utility	32	0	0	64	24	160	_
	<u>AH-64D</u>	160	06	20	135	114	569 758 ²	ı
	RAH-66 AH-64D	288	150	222	297	240	1197¹	

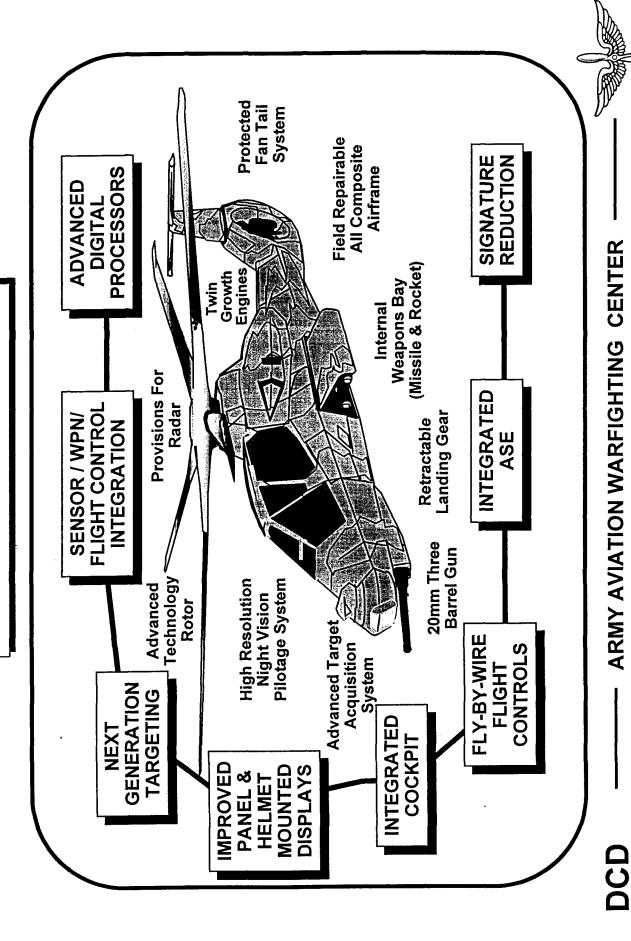
² Interim requirement until RAH-66 Fielding to heavy division/corps attack battalions. Far-term AH-64 requirement after RAH-66 fielding = 569. ¹ Assumes deactivation of TARCs/TARPs

Sustainment Account (Float, Attrition, TDA, Training) = 25%. Combined UH-60 Sustainment Account = 25%. SOA Objective Requirements Not Included (45 MH-60L/K, 37 MH-47D/E, 16 RAH-66, 30 MELB) Requirements Do Not Include Special Electronics Mission Aircraft (SEMA) EH-60 (80 plus float)

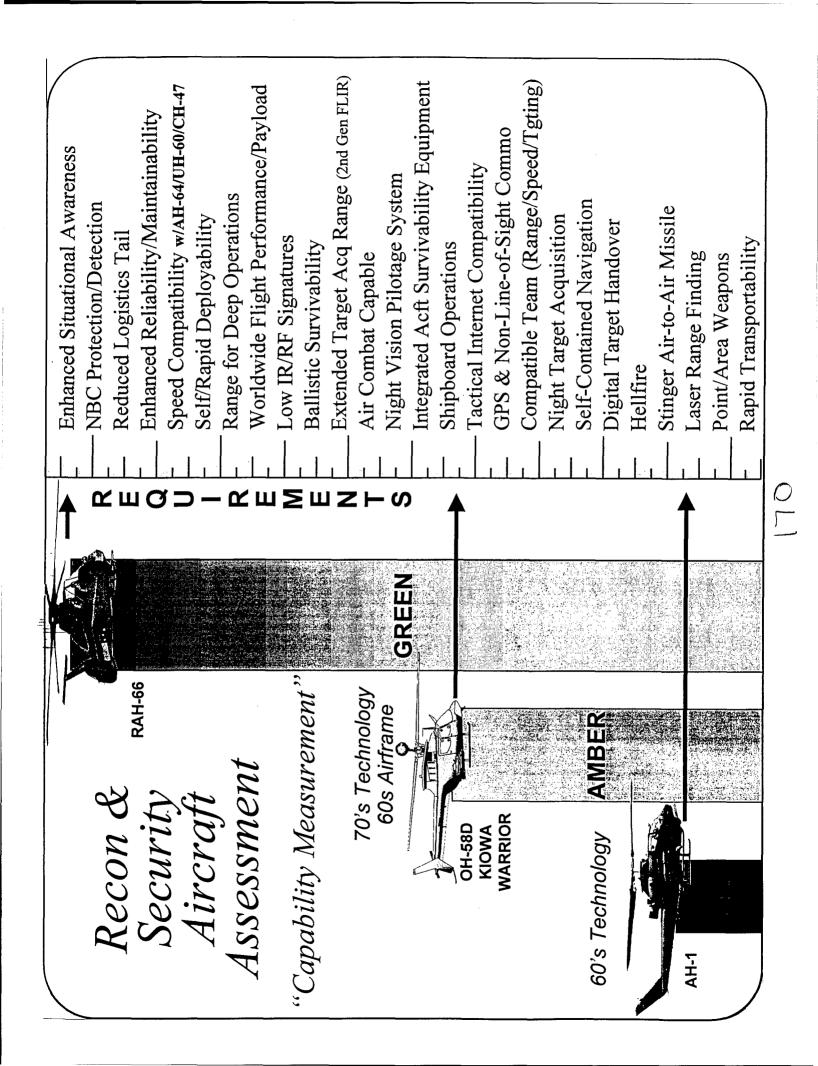
* Force Packaging Per SAMAS under TAA-03

RAH-66 COMANCHE

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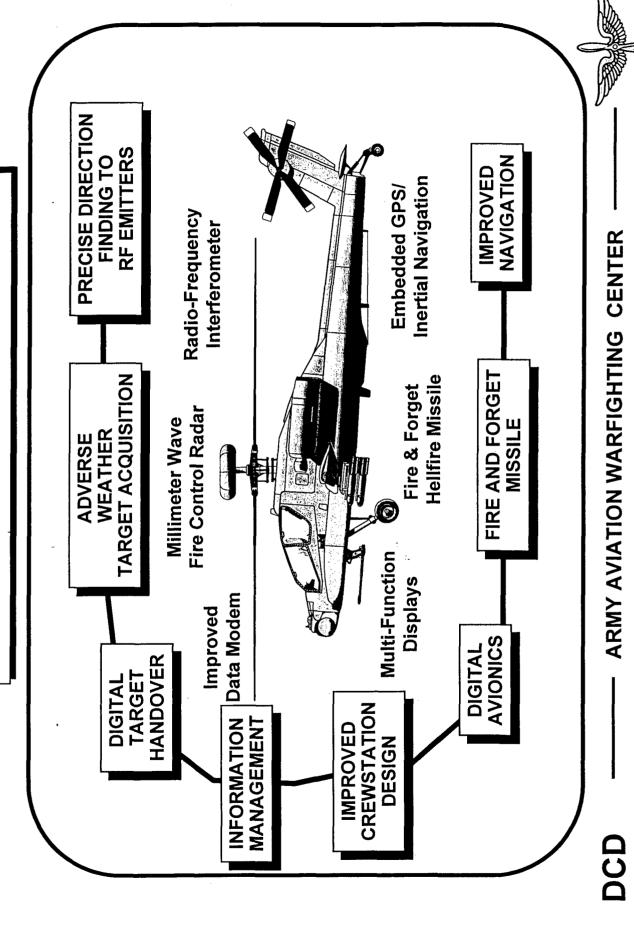


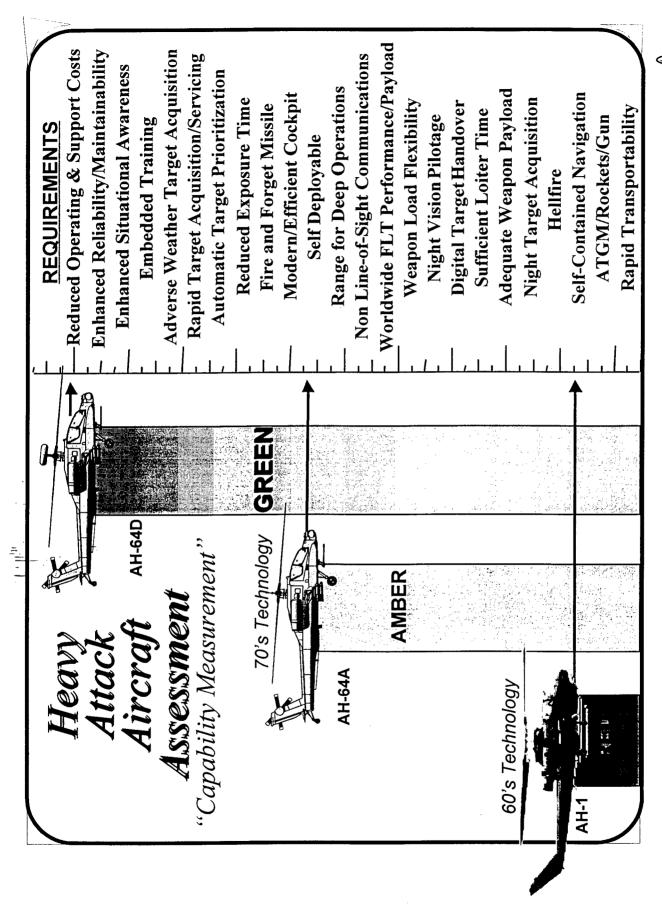
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AH-64D LONGBOW APACHE

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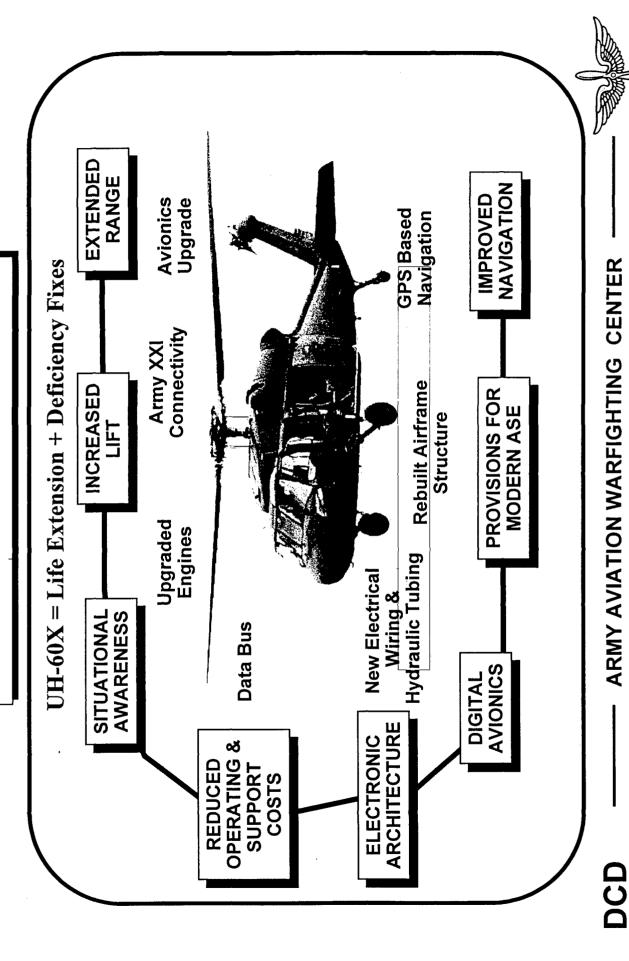




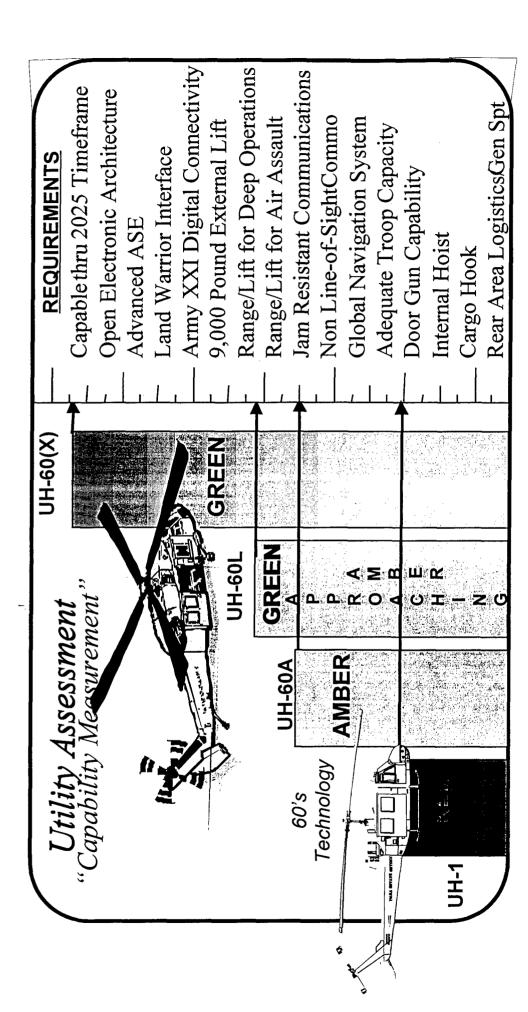


ARMY AVIATION WARFIGHTING CENTER

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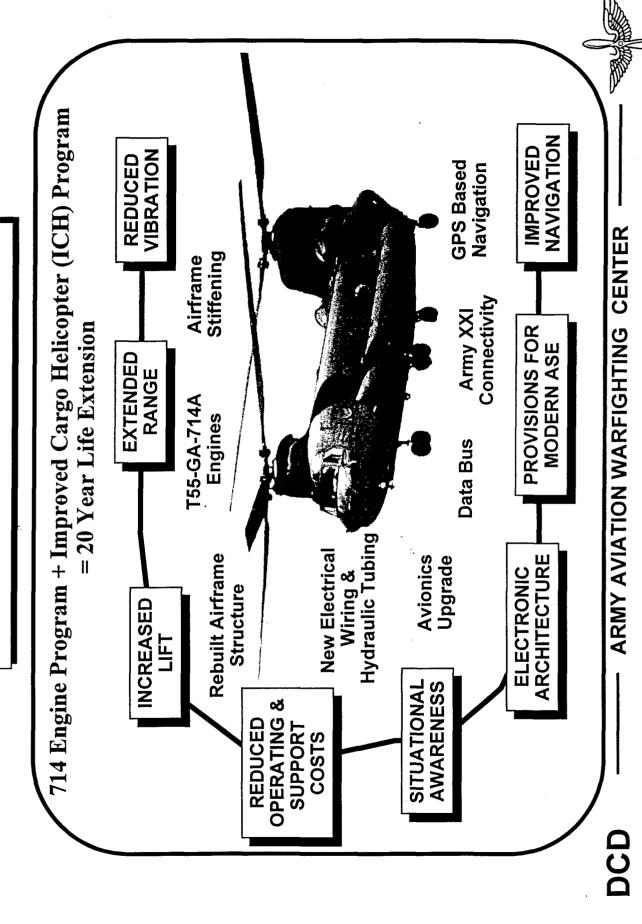
ARMY AVIATION WARFIGHTING CENTER -



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CH-47 MODERNIZATION



5

-- Future Lightweight Howitzer w/Ammo, Advanced Aircraft Survivability Equipment -- Future Aviation Forward Arming & Crew, & Digital Fire Control Transport 31 Troops/100 NM radius Non-Line-of-Sight Communications Transport 16,000 lbs, 50 NM radius Electronic Architecture (data bus) Tactical Internet Compatibility REQUIREMENTS -- Dual TOW HMMWVs Refueling System 10NM radius/15,000 lbs. Reduced Vibration -- M198 Self Deploy Modernized SEEKIO) **CH 47** "Capability Measurement" Assessment **CH47D** Cargo

- ARMY AVIATION WARFIGHTING CENTER

DCD

Line of Sight Communications

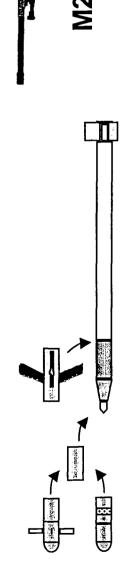
Global Navigation

Internal / External Loads



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Weapon Modernization Programs

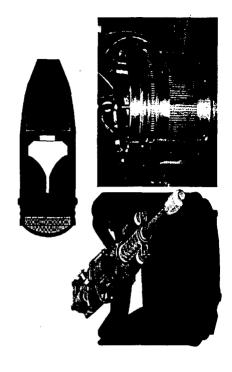




Advanced Precision Kill Weapon System



Modernized HELLFIRE Longbow HELLFIRE PIP



MultiRole Aviation Weapon System

DCD

ARMY AVIATION WARFIGHTING CENTER



Aviation Modernization Strategy Rotary Wing Fleet Inventory* Projections

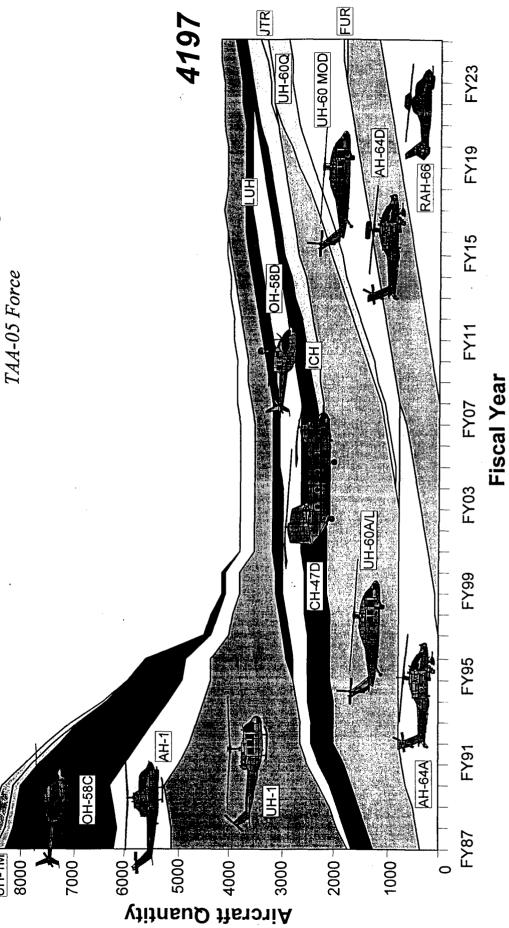
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* Excludes SEMA and SOA includes 25% Sustainment Planning Factor

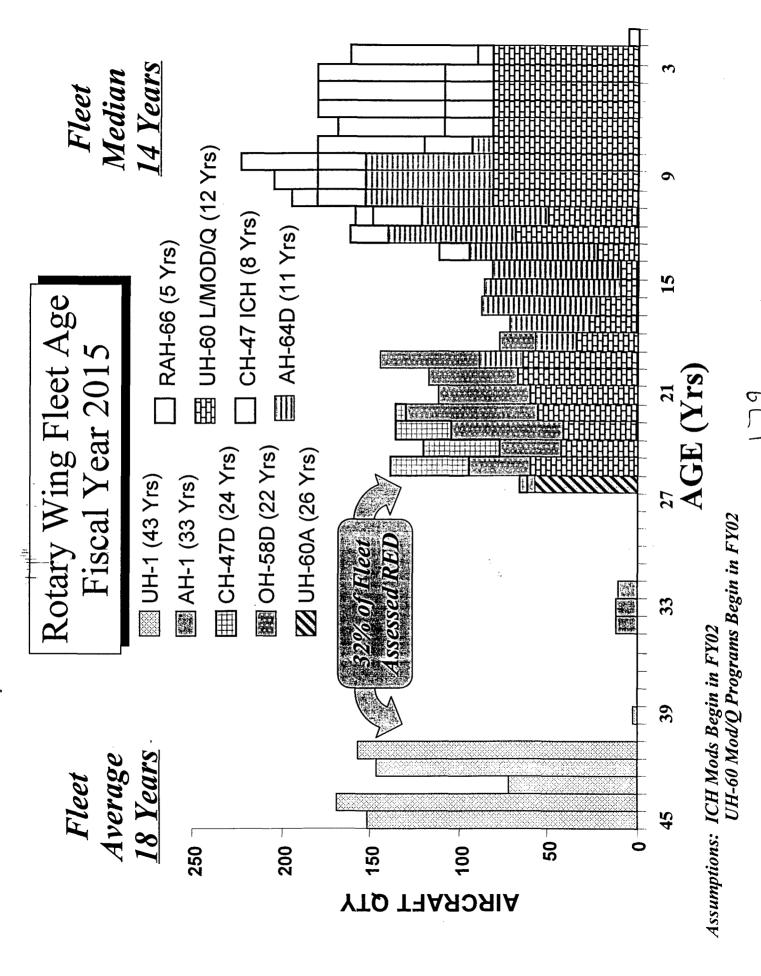
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UH-1M

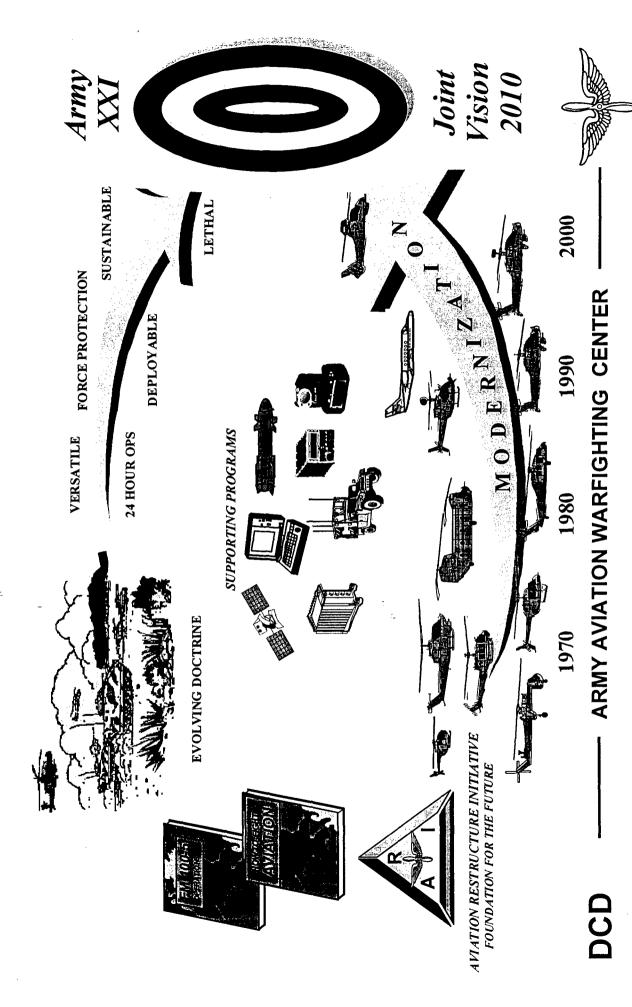
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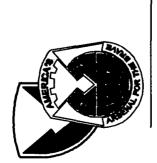
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ADVANCING ON THE 21st CENTURY **AVIATION**



08/





Mobility and Firepower for America's Army



Tank Lethality Technology Development Update

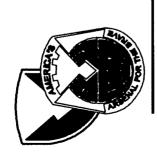
Anthony J. Sebasto Systems Manager (973) 724-6192 Tank-automotive & Armaments COMmand





Outline

- Technology Thrusts
- KE Ammunition Technology Trends
- Current Initiatives
- ▶ Future Initiatives
- HTI Opportunities
- **Summary**





Major Technology Thrusts



- Defeat of Advanced Generations of Explosive Reactive Armors & New Complex Armors
- Extended Range Line-of Sight and Beyond Line-of-Sight Engagements
- Increased Accuracy at Extended Ranges Under ALL **Vehicle Motion Conditions**
- Advanced Propulsion Options Increasing Lethality While Reducing Vulnerability
- Wear and Erosion Resistant Barrel Coatings



Kinetic Energy Ammunition Technology Trends



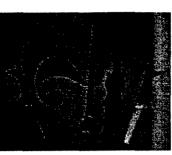
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1995	2000	2002	2010	2015	5020+
M829 Series	Series			4	
				\	
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PM Funded:

- Lighter Sabots
- Advanced Propulsion
- **New Penetrator Alloys**





Tech Base Components

- Novel Penetrators
- Adv Propulsion (Conventional/Electrothermal-Chemical)
 - Axial/Radial Thrusters (Enhanced Accuracy)

Hypervelocity Launch

Novel Penetrators (Monolithic, Segmented, etc)

Bottom Line:

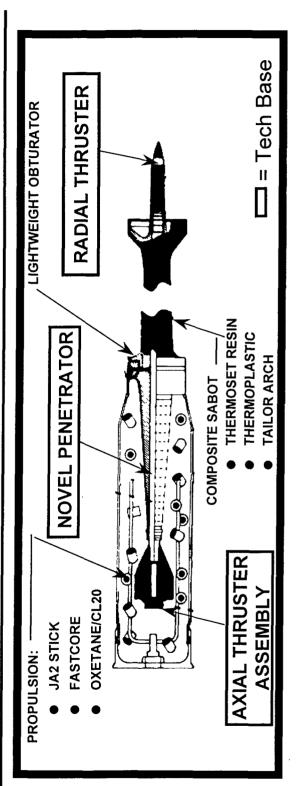
- Armor Configurations Becoming More Complex
- Multiple Defeat Approaches Being Investigated

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Advanced KE Cartridge Program (Direct Fire Lethality ATD)





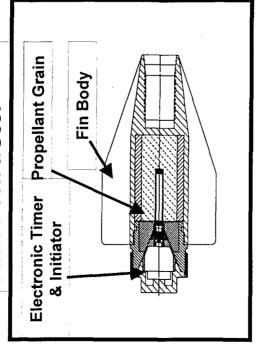
- Defeat of Explosive Reactive Armor Protected Threats And Increased System Accuracy FY97-01
- 40-70% RHAe Penetration Increase Over M829A2 At Extended Ranges
- 30 70% Increase In Probability Of Hit Over M829A2 At 3 KM
- Transition To PM-TMAS In FY01
- KEY PLAYERS: ARL, ARDEC, DARPA, PM-TMAS, USAARMC, Industry



Enhanced Accuracy KE Technologies

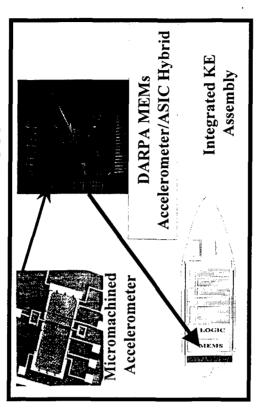


Axial Thruster



- Compensates for Aerodynamic Jump Error
- Up to 30% Increase in First Shot Hit Probability
- KE Course Correction Feasibility Demo Sept 98
- Transition to PM-TMAS

Radial Thruster

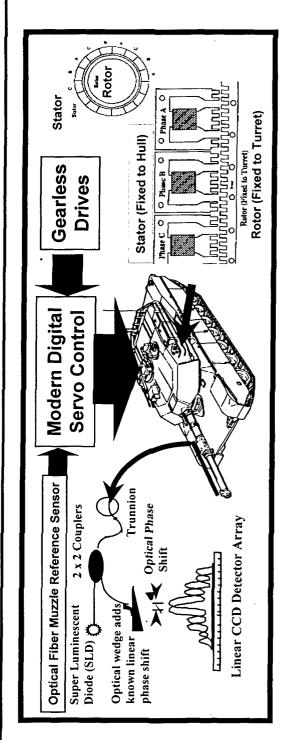


- Compensate for Total Jump Errors
- Leverages DARPA MEMs Accelerometer Technology Development
- Up to 70% Increase in First Shot Hit Probability
- Feasibility Demo With M830A1 FY98/99
- Miniature Thruster Demos FY99/00
- Integrated KE Penetrator Demo & Transition to PM-TMAS in FY01



Advanced Drives and Weapon Stabilization (Direct Fire Lethality ATD)





- Integrate Promising Technologies To Reduce System Errors Under Moving Conditions and Reduce O&S Costs (FY96-01)
- Demonstrate Increased Probability Of Hit Of 200% Over M1A2 At 3 KM Under Moving Conditions
- Validate, Through Analysis, Life Cycle Cost Savings With Elimination of Hydraulic/ Radioactive Components and Increased Reliability/Maintainability
- Transition To PM-Abrams In FY01
- KEY PLAYERS: ARDEC, PM-TMAS, PM-Abrams, USAARMC, Industry



Tank Extended Range Munition (TERM)







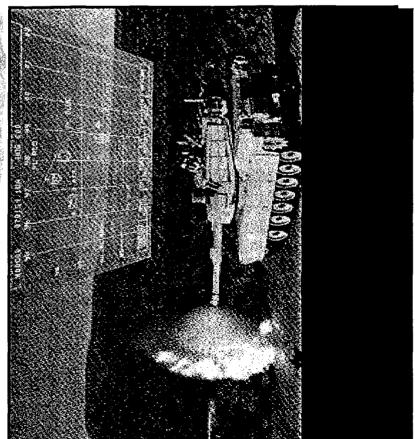


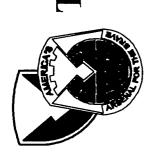
Battlefield)

The capability to Shape his battlespace

 Engaging RISTA & C2 elements setting the stage for successful <u>Decisive Operations</u> (Close Fight) Expands the capability of the M1A2 SEP Tank

♦ Will become a mainstay of Legacy Forces





Tank Extended Range Munition (TERM) Advanced Technology Demonstration



Acquisition Strategy

- Rigorous Front End Analysis (Joint ARL/RDEC/PM/User)
- Validate TERM Utility And Establish Technical Performance Potential
- Early Pre-Solicitation Communications With Industry
- Aug 97 Industry Day (Distribution of RFP, ORD Requirements For Comment)
- Senior Advisory Board "Sanity Check" (Oct 97)
- Contract Phases:
- 9-Month Phase
- » Up to three contract awards (Planned Jun 98)
- » Detail candidate concept designs
- 39-Month Phase II
- » One or two candidates
- » Conduct key performance demonstrations
- » Demonstrate ATD Exit Criteria
- Transition to PDRR or EMD in late FY02

Possible Fast Track Acquisition Candidate



Electrothermal-Chemical Propulsion (ETC)





- INCREASE LETHALITY:
- Higher Muzzle Energy
- Exploit novel KE concepts
- Potential for Hypervelocity: Up to ~2.2 km/s
- MINIMAL ELECTRIC POWER
- CONTROL OF IGNITION/COMBUSTION:
- Precision ignition => improved accuracy
- Eliminate temperature sensitivity => improved lethality
- Advanced hi-energy, lo-vulnerability charges => improved lethality and survivability

06-1



ETC Development Roadmap



Near Term Program (1999-2001)

- Low electrical energy
- Existing guns (M256/XM291)
- · Advanced conventional propellants
- Grow muzzle velocity/launch mass

Continued Development 2000-2002+

120mm gun technology growth

 Advanced projectiles Novel propellants









Supporting FCV/AAN Armament STOs

· Embedded Temperature Sensors

 high specific energy lower vulnerability

Far Term (2015+)

- Advanced power & propellants
- Hypervelocity potential
 - Low Vulnerability
- Tailored Launch Performance for Future "Family of Munitions"









LARGE CALIBER ARMAMENT WEAR and EROSION









INDIRECT FIRE: Barrel / Projectile



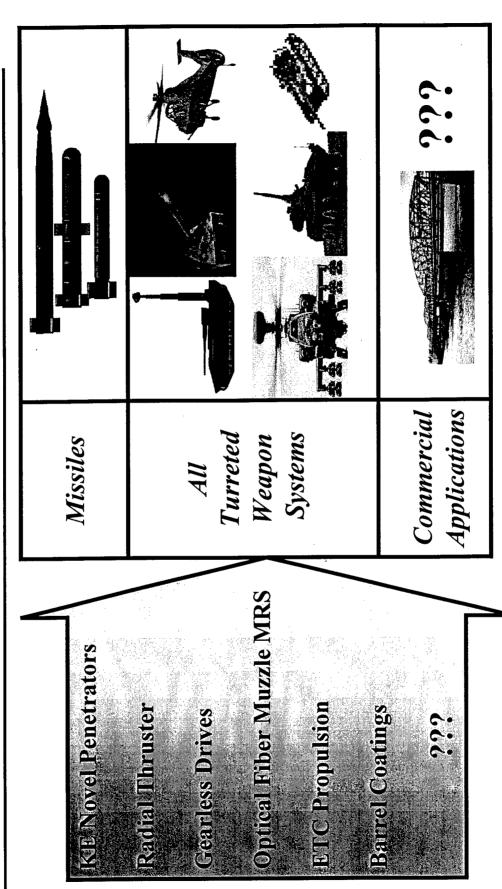
Compatibility Issue

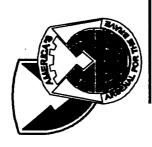
- Demonstrate Promising Technologies to Reduce Evolving Wear and Erosion Issues (FY96-06)
 - Current Tech Base Approaches:
- Wear and Temperature Resistant Barrel Coatings DIRECT FIRE:
- High Energy Low Temperature Propellant Formulations INDIRECT FIRE: - Improved Band and Obturation System
 - Deliverables:
- Med Cal Barrel Coatings Demonstrator by FY01 · DIRECT FIRE:
- Scale Coating Technology to Large Cal by FY04 (MTO Proposal)
- Improved Propellant Formulations by FY02
- Band Obturation System for ERO by FY01 · INDIRECT FIRE:
- Obturation Retrofit Design for Inventory by FY01
- Coatings Technology Transitionable to Industry by FY01 (Med Cal Barrel Producers)



Horizontal Technology Integration Opportunities







Summary



- Investment in Lethality Sustainment a Major Priority
- Tech Base Providing Key Performance Gains
- New initiatives (i.e. TERM) can provide Abrams (w/FSCS) **Army After Next Capabilities**
- Industry/OGA Responding to Lethality Challenges
- Opportunities Exist to Team With Industry and Other Services for Technology Transfer



Fire Control for Force XXI and the Army After Next

Armament Research Development and Engineering Center Fire Control and Life Cycle Software Engineering Division Fire Support Armaments Center Picatinny Arsenal, New Jersey

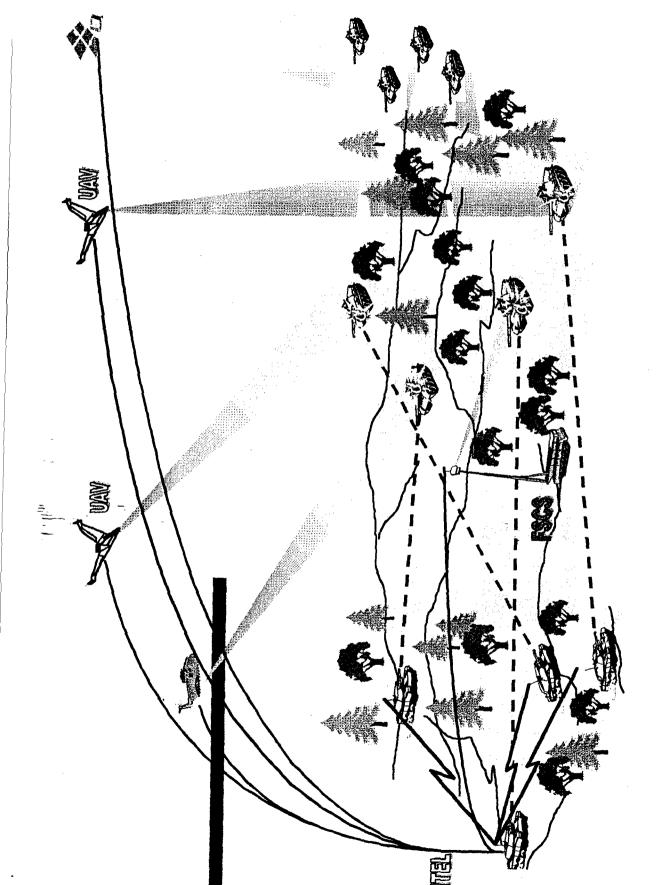


Description/Definition

MULTI-AGENT FIRE CONTROL SYSTEM

distributed battlefield platforms that act in concert with one and efficient application of firepower assets to engagement another to provide enhanced firing solution computation A linked fire control system framework consisting of of individual and multiple targets. Linking may be considered through a collective or master-slave configuration.







Description/Definition

Software Based / Software Development and Implementation

- Maximum use of existing system hardware / C4 JTA & HTI compatible
- FBCB2 as crew interface / Appliqué for future use
- Uses existing computer/ADP hardware/NAV package/Long haul
- Applies Multi-Agent Fire Control algorithms
- Purpose
- Rapid Point Fire Maximum Ph Engagement and Mass Fires
- TERM/ERM/BLOS
- Fire control baseline for AAN



Description/Definition

Software Modules and Functions

Target Position Measurement

Data Filtering

Target Position Conversion

Mass Fires/Point Fires Selection

TERM/ERM BLOS Selection

Terrain Profile Intervention

Weapon/Sight Pointing Control Meteorological Compensation Own Vehicle Dynamics Measurement

Target Dynamics Measurement

Data Processing:

Ph Calculation

Target Prioritization

Target-Shooter Assignment

Crew Override

System Control/Run Time

Own Vehicle Position Measurement

Display Drivers



Description/Definition

Crew Tactile Interfaces

FBCB2 - Touch Screen / Icons

Commander's Control Handle Switches

Gunner's Yoke Switches / Palm Switch

Dead Man Switch (Crew Override)

Communications Interfaces

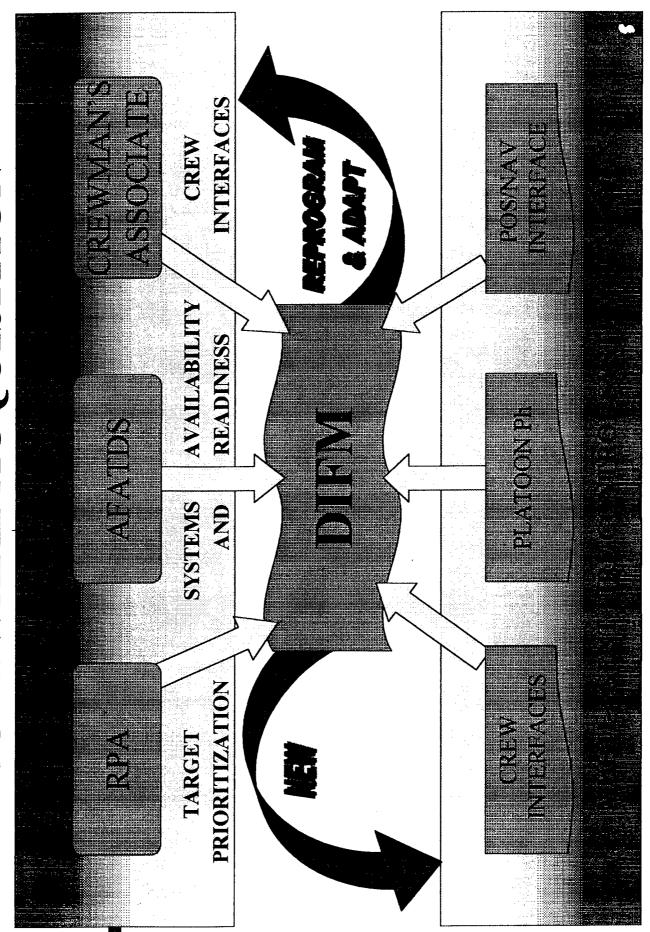
Improved Data Modem SINCGARS (Incoming Assignments)

Low Power Wireless LAN (CO/PLT/Team)

Protocols

Position/Location Interfaces
GPS/PLGR
VNAS

SOFTWARE ACQUISITION





Concept Features/Characteristics

- Provides REAL-TIME tactical fire assignments and adjustments throughout the battle
- Dynamic operation running continuously in background (transparent to user)
- Uses calculated Ph values for target assignments to each firing platform
- Filters available data to extract needed information

- Compares real-time instantaneous status of each firing platform (positions, rates, ammo, ready rounds, stabilization status, etc.)
- Uses a collective or master-slave approach to laying of individual firing platform guns
- Checks validity of available data acquired from each system and utilizes most valid available information



Sample Data Elements

- Target position (UTM or other)
- Target velocity, acceleration and direction
- Target state prediction
- Target threat prioritization

Non-standard conditions:

- Crosswind/rangewind velocity
- Propellant grain temp
- Muzzle position distortion
- Terrain data
- Elevation/contour
- Line of sight intersection

- Firing platform state
- Cant
- Roll/pitch position and rate
- Multi-axis acceleration values
- Ready round type
- Target plane angle to line of sight
- Range to targets
- Firing platform target data quality
- Tracking data noise
- Image quality
- Data consistency
- Range false returns



Is Not:

- A command and control system
- A communications system
- B2C2 / CVCC / IVIS / FBCB2 / Appliqué
- Intended to be a planning or logistics status assessment
- A graphical display terminal or other crew interactive

But:

Must interface with all of these items, as appropriate, in order to function



Payoff

- Uses best platform and target position measurement data to compute pointing solutions and hit probabilities for all unit elements (Improved small unit engagement accuracy)
- Mitigates the potential of overkill or underkill problems during multiple target engagements (No overlap and improved engagement efficiency)
- Reinforces ammunition conservation; mitigates "overkill"
- Enhances the effectiveness of TERM and other advanced ammunition concepts

- Reduces the possibility of friendly fire/fratricide using multiple vantage target data and passive visual interrogation before fire
- Takes maximum advantage of available multiple platform sensors to improve target state estimation and battlefield awareness
- Makes excellent use of an extensive and flexible C2 system
- Prioritizes data handling through mission parameters (Improved target servicing rates/rapid reaction)



Status

- evaluate merit in terms of user needs that are satisfied, and to DFD USAARMC directs TRADOC CEP using Battle Lab to identify what features are of highest value
- LTG Abrams (DCG, TRADOC) redirects CEP SOW to result in effective implementation of DIFM for M1A2 SEP system
- CEP plan and model acquisition being finalized
- Tech Base \$ committed to TERM STO for DIFM/TERM fire control task
- PM-TMAS, ARDEC (FSAC/CCAC) seeking additional funding sources and support
- Additional unfunded STO requirement exists
- CRADA with industrial partner(s) welcome



Approach/Plans

■ MAFCS CEP Kick-off meeting - July 1998

Complete TRADOC CEP - November 1998

Initiate DIFM/TERM STO Fire Control Task **October 1998**

Initiate DIFM STO Program - October 2000

Complete TERM STO Fire Control Task

- September 2002

Complete DIFM STO Program - September 2003



Point of Contact

Fire Control and Life Cycle Software Engineering Division Fire Support Armaments Center **US Army TACOM-ARDEC**

DSN 880-6028 / Comm. 973-724-6028 / FAX 973-724-5360 Clifford W. Langan, P.E. Operations Manager Direct Fire Branch AMSTA-AR-FSF-D



TACOM - ARDEC Picatinny Arsenal







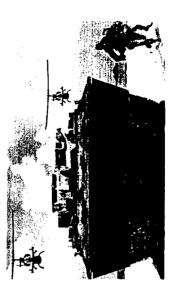
J.S. Army Medium Caliber S&T **Business Area**





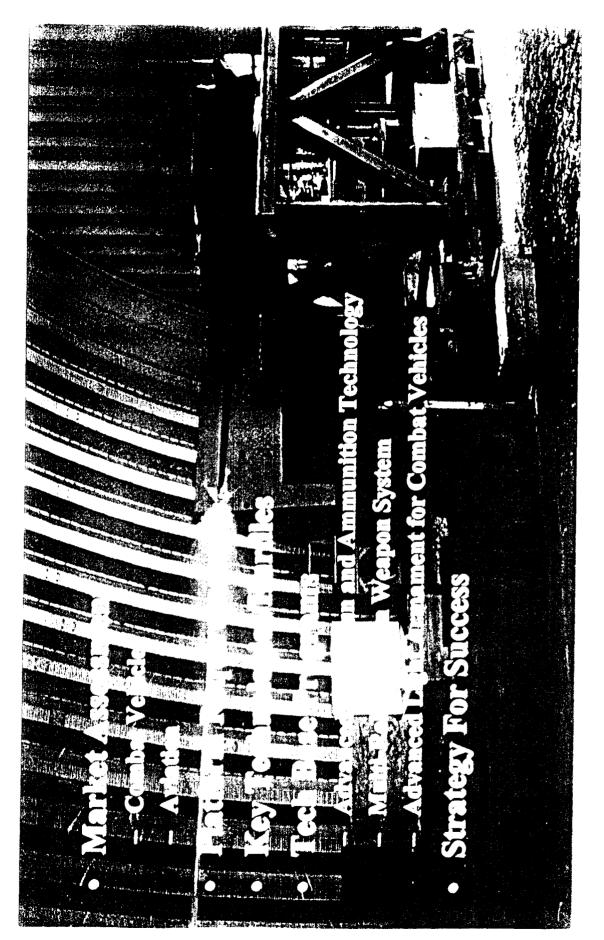


mmadden@pica.army.mil















Market Assessment



USMC AAAV (Approx 1000 vehicles)

• IOC FY06

- Future Scout Cavalry System (Approx. 1600 vehicles)

• ATD FY98-01

• EMD FY02-06

Future Infantry Vehicle (Approx. 1600 vehicles)

• EMD FY12

- Bradley Upgun

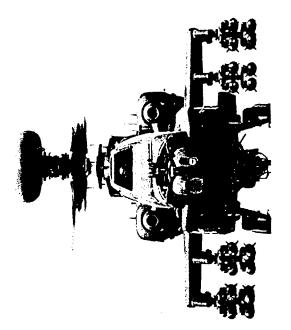
• No current plans.





Market Assessment

- Aviation Platforms
- Longbow Apache Upgrade(Initially 382 vehicles)
- EMD 02/Production 04
- Comanche (Approx 1200 vehicles)
- EMD 02-06







Customer Gun System Requirements



Combat Vehicles

- Acquisition approach; "NDI"
- Anti-Personnel
- Prone Defilade Troops
- Foxholes
- ATGM Sites/Bunkers etc. Lt. Trucks
- · IFV's
- BMP 3 and beyond
- Self Air Defense











Customer Gun System Requirements

Aviation Platforms

- System Accuracy
- Reduced AmmunitionCapacity
- Air-To Air Capability (MNS)
- Improved Reliability
- Reduced O&S Costs
- EMI Sensitivity





30mm Ammunition Interests

- Multipurpose
- Product Improvement of PGU-13 (PBXN-5) and PGU-14 (Tungsten)
- Airburst Munitions
- Completed Phase I study in March 98
- 40mm Super Shot Family of Ammunition

Fighting FCV Concept



- Fighting vehicle team
- Manned (crew of 2 in hull) RSTA & direct fire
- Unmanned precision NLOS
- 22-27 ton FSCS derivatives (likely to be tracked ... frontal appliqué armor leads to 27 tons)
- Low silhouette
- Signature management



- Manned 22-27T version
- Missile/gun combination, plus designator for NLOS:
- 4-6 CKEM mini-LOSAT (use vs MBT only)
- Fire on the move
- Med cal (> =35mm) cannon (suppression & all other targets, incl aircraft)
 - Call for NLOS missile vs longer range, less threatening targets
 - Appliqué armor vs medium caliber threats (frontal arc)
- APS vs CE, large KE and top attack



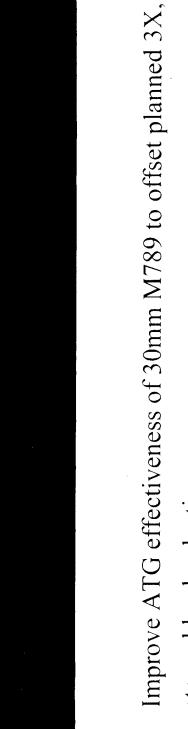


- Unmanned 22 ton version
 - Simple robotics (follower)
- Maximize missile payload and avoid firing signature for manned systems in most cases
- NLOS top attack CE missile:

 HELLFIRE III dual mode
 with ~12km max range
- Fire on the move
- Response < 30sec.

Future Secondary Armament

- Platforms with Interest
- Crusader
- FSCS
- FIV
- FCS
- HMMWV
- Initial S&T Investment under MRAWS, focusing on System Concepting
- Integration of OCSW and other Technologies
- Teamed with PM-Small Arms and FSAC



- stowed load reduction
- Demonstrate ATA capability in addition to ATG improvements
- Demonstrate potential of new bursting munition over current NDI solutions
- Development of system improvements required to fire Airburst Munitions
- Development of optimum long rods
- Validate NDI candidate cannon system performance

Personal of precision and account

Advanced Light Gun and Ammo

Technology (FY98)



KE Rods

Materiel Novel Penetrator



Bursting Munitions

OCSW/OICW European candidates

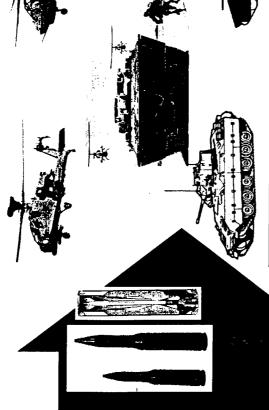
NDI Cannons

Bushmaster |||

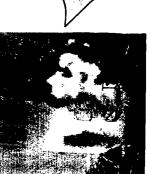


Gearless Turret Drives

Leveraging on-going technologies for future platform needs



Providing Verified
Weapon Concepts
with Performance and
Logistics Improvements





510



FY 97 Tasks:

- 25mm-45mm bursting munitions study /market survey 1
- Supplemental penetrator terminal effects study (ARL).
- Fire control error budget study (35-mm baseline gun).
- Spin stabilized shape charge investigation (helicopter applications)
- The second secon

FY 98 Tasks:

- Fire control weapon stabilization definition (AH-64)
- NDI 35mm Bursting Munition evaluation
- 30mm Longbow ammunition concepting

Summary of Autocannon Candidates

▶ 25-mm M242

- In production for Bradley
- AP performance maximized
- HE growth: bursting munition

◆ 30-mm Bushmaster II

- FMS to Norway
- GAU-type ammo
- Selected for AAAV prototype
- Growth to 40mm Supershot

◆ 35-mm Bushmaster III

- Prototype cannon
- Gun fits Bradley A2
- Good performance (current & projected threats)
- Growth to 50-mm Supershot technology

40-mm CT-2000

1st gun prototype due Spr. 97 Gun /feeder fits Bradley A2 Mann Barrel demo Dec.97

40-mm Bofors L70/B

In production for CV90 Cumbersome (21-inch long) ammunition Ammo performance only marginally better than 35 mm

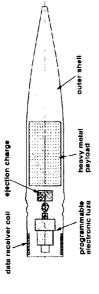
45-mm CT-2000

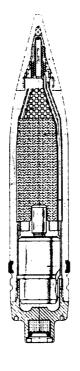
Prototype cannon Significantly larger size Cased Telescoped Ammo

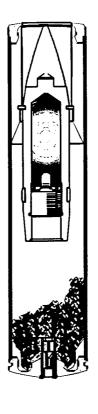
Variable Timed Fuzing Technologies

- 20mm OICW / 25mm OCSW
- Multi-functional (PD/Timed/Delayed PD)
- Less aggressive launch environment
- 35mm AHEAD "Time Fuze"
- In production for "Skyshield" air defense gun system
- Inductively set @ muzzle
- 35mm German Time Fuze
- Production ready
- Inductively set at chamber
- 40–45mm CTAI Time Fuze
- Developing optimized fragmentation warhead
- 40mm Bofors 3P
- Proximity fuse







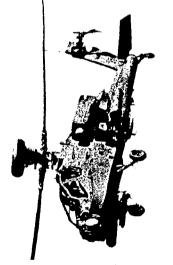


MultiRole Aviation Weapon System ARD-07



Improve M789

Spin Compensated Shape Charge Liner Steel Case/Compacted Propellant Proximity/Bursting Fuze



Light Armor

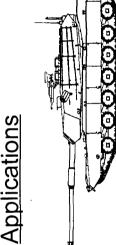
Air to Air 🖔



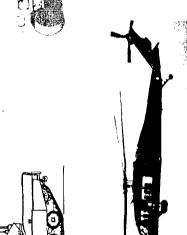
Antipersonnel



Precision Primary and Secondary Armament



Composite Structure



Advanced Electric Drive

Advanced Light Armament for Combat Vehicles (FY01-03)

Bradley

·FIV

FSCS

·AAAV



Novel Penetrators KE Rods Materiel

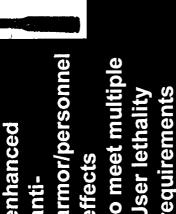


Bursting Munitions

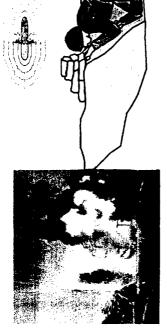
European candidates OCSW/OICW

future combat vehicle needs Leveraging on-going technologies for

armor/personnel **Demonstrate** enhanced effects Goals:

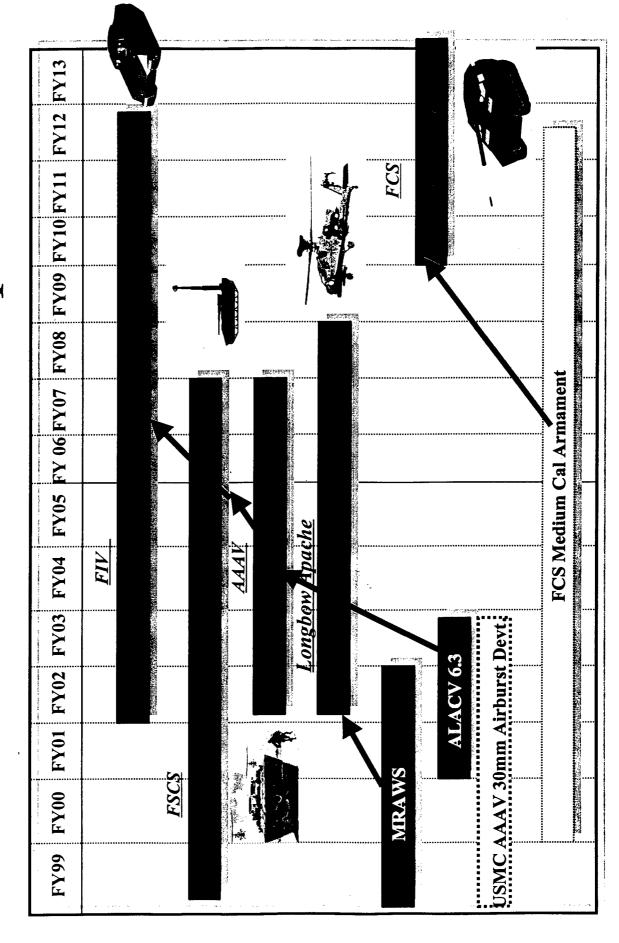


<u> Anti-Armor/Personnel</u> Providing Enhanced Effects for Ground Combat Vehicles



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S&T Transition Roadmap



S C C



Conclusions



- Growing Business Area for TACOM-ARDEC
- S&T Interest Finally expressed in Medium Caliber S&T
- Advance Light Gun and Ammo Technology (FY98)
- Multi-Role Aviation Weapon System (FY99-02)
- Advanced Light Armament for Combat Vehicle (FY01-03)
- Programs budgeted and supported for the following interests:
- Longbow Apache
- Ammunition for Future Combat Vehicles (FSCS, FIV, AAAV)
- Secondary Armament for both air and ground platforms
- PM Support (Both moral and financial)
- Joint program opportunity exists with USMC, AAAV
- New Interest in Medium Cal solution for FCS, per Dr. Milton

National Defense Industrial Association

Armaments for the Army of the Future
24th June 1998

David Leslie

CIA INTERNATIONAL

Presentation Outline

Background
Why CT Technology is required
Where CT Technology is today
Integration benefits of CT Technology
Benefits of Ownership

CTA International



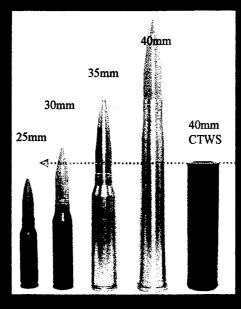
Investment since 1994 - \$30M Investment commitment - \$20M CTAI is a joint venture company 50 50 BAe and Giat Industries.

Dedicated team, 33 strong. British and French engineers and scientists Total company focused on development of 40mm Cased Telescoped Weapon System

Program funded from industrial investment

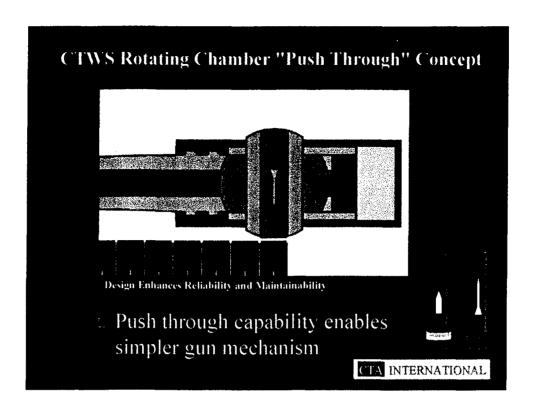
CTA INTERNATIONAL

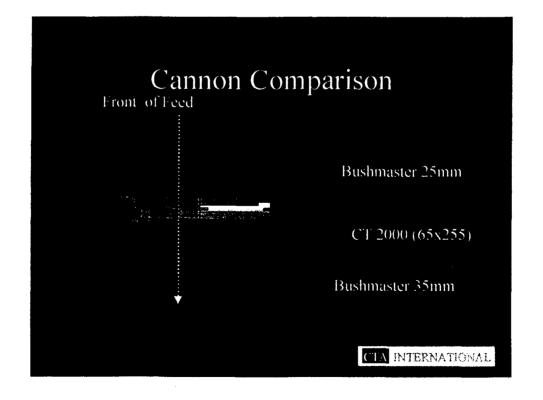
Ammunition Comparison



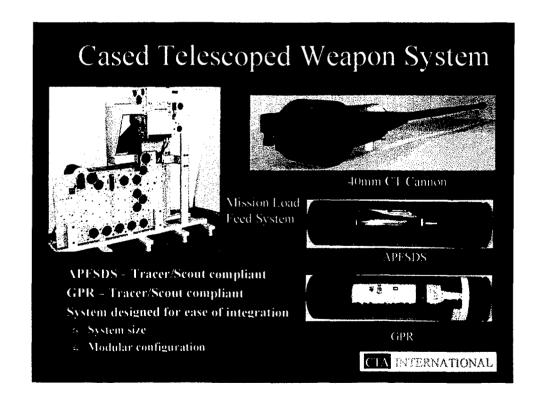
30% saving in volume for the same performance

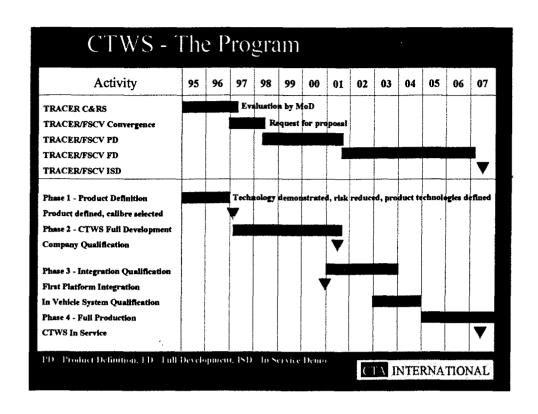
30% more performance for the same volume

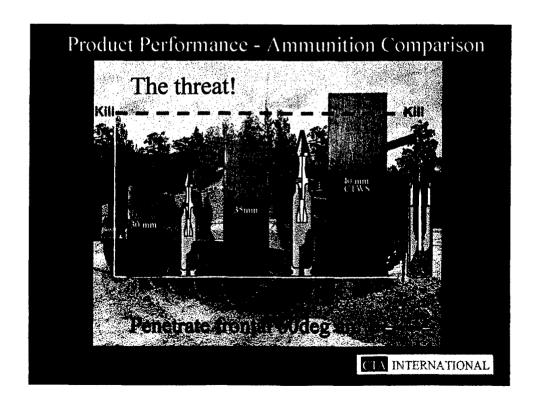






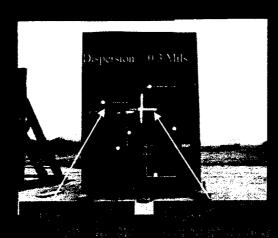




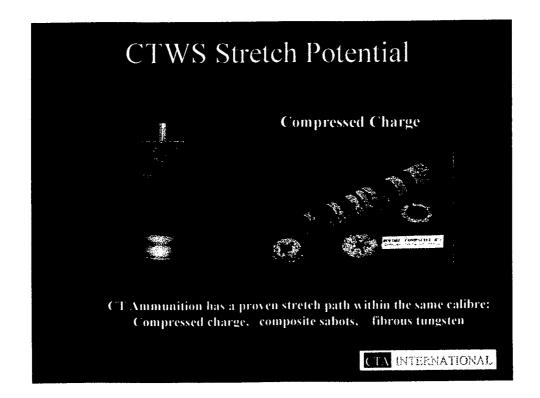


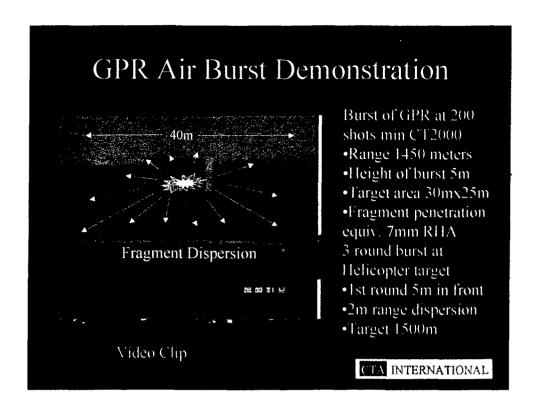


40mm CTWS at 1500m

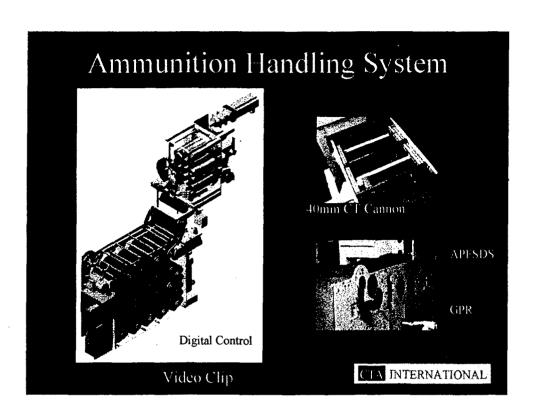


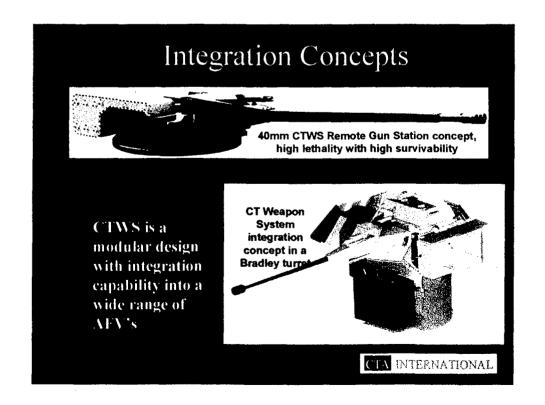
APFSDS service round Loose fill propellant Tungsten rod APFSDS stretch round Compressed charge Lungsten rod Target 1 150mm RHA plus Behind Armor Pack Target 2 160 RHA (20deg) plus Behind Armor Pack

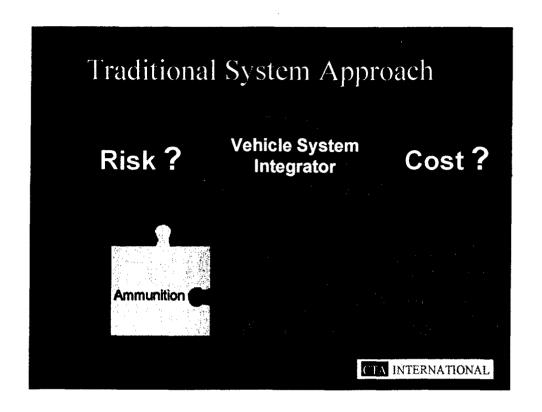


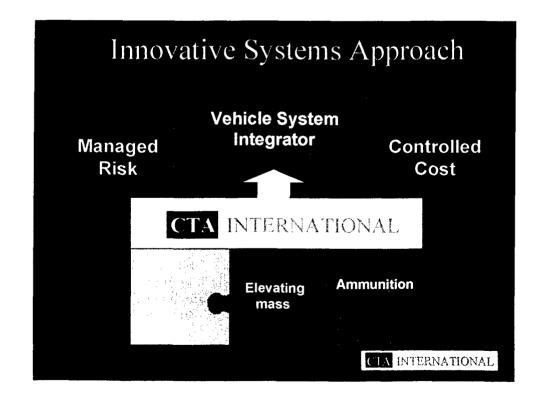


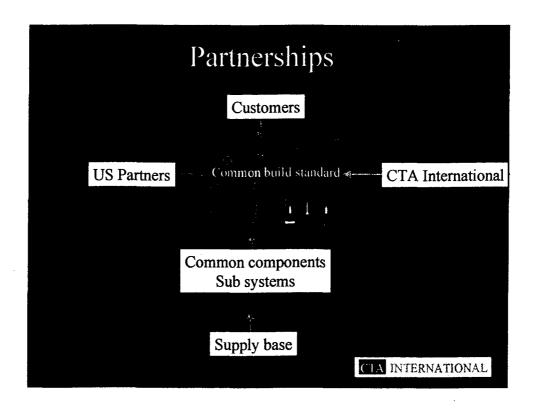


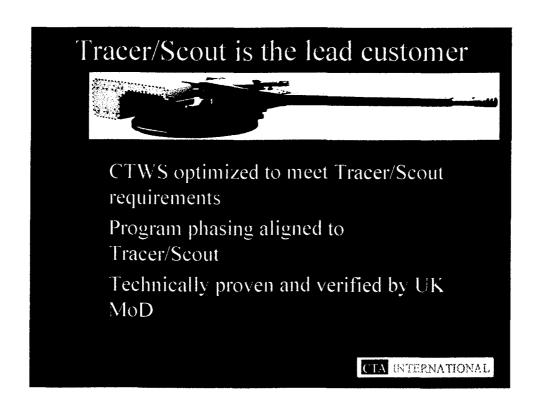






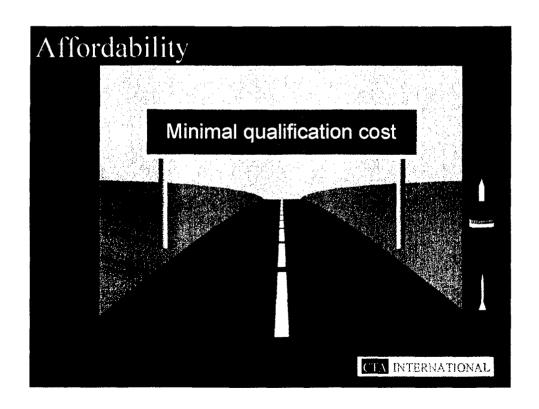


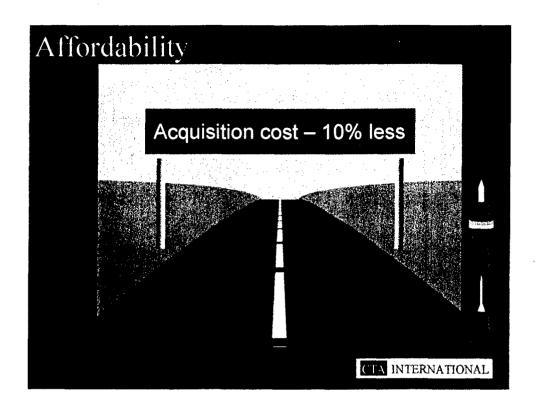


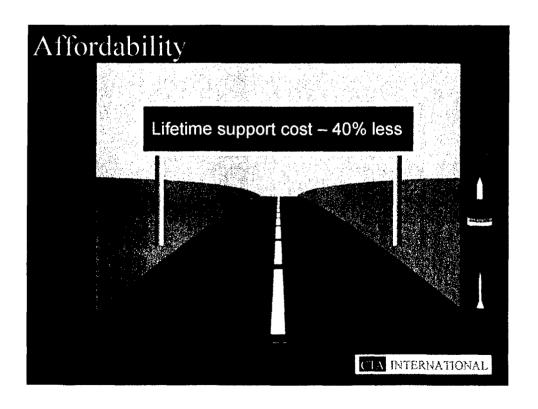


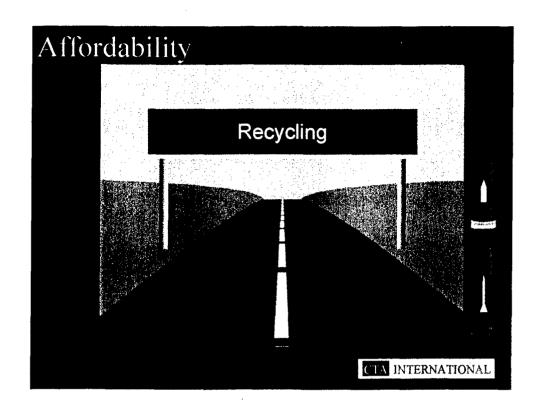
Product Maturity

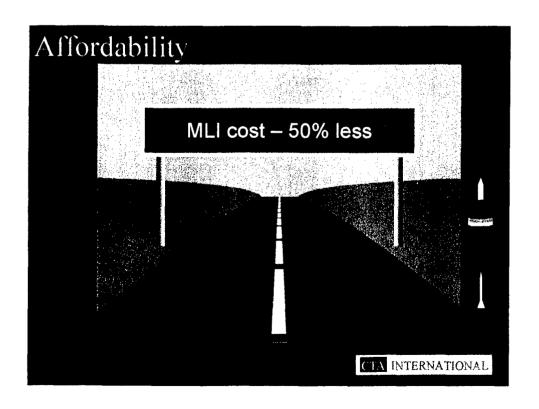
- Technology demonstrated
- Full development programme underway
- Company qualification process supported by UK Mod-Ordnance Board
- ISD Armour threat defeat demonstrated
 - GPR effective with time burst fuzing demonstrated
- : Linkless Feed system technology demonstrated
- **Stretch Path demonstrated**

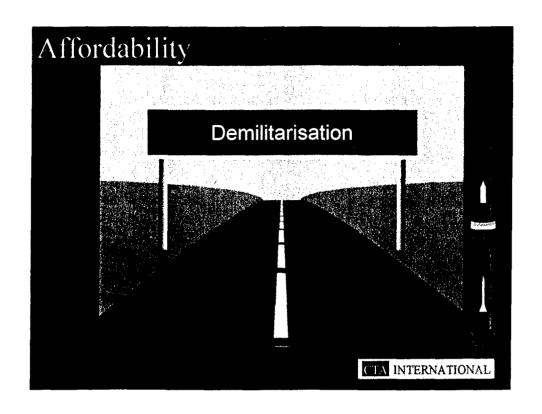


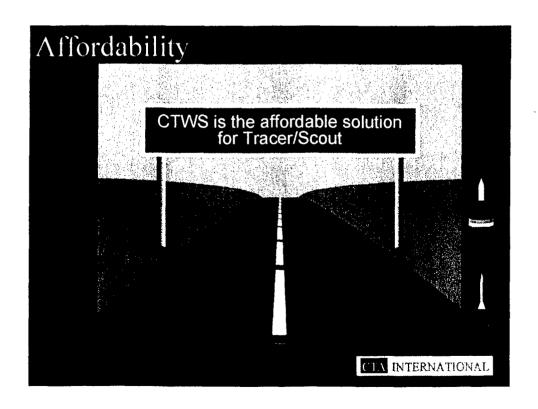












CTWS Benefits of Ownership

Product performance
Product maturity
Affordability
Integration benefits
System approach



CIA INTERNATIONAL

Benefits to CTAI Customers/Partners

CTWS can, through innovation and investment, deliver at low risk:

- Reliability
- Affordability
- Performance
- Lull life support

Government agencies can, through acquisition reform and sound scientific advice deliver:

- Acceptance of new technologies.
- Updated qualification procedures

40mm CTWS Low Risk!









Logistics Technology Update

U.S. Army Defense Ammunition Logistics Activity Robert A. Rossi 974-724-2188



DEFENSE AMMOLOG ACTIVITY



ARDEC

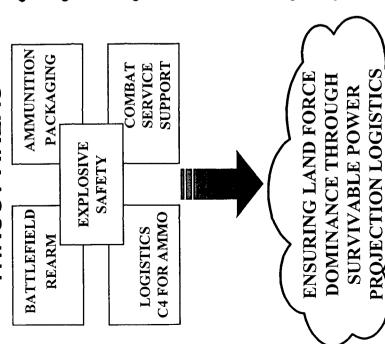
Tank-automotive & Armaments COMmand

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U.S. Army Defense Ammunition Logistics Activity

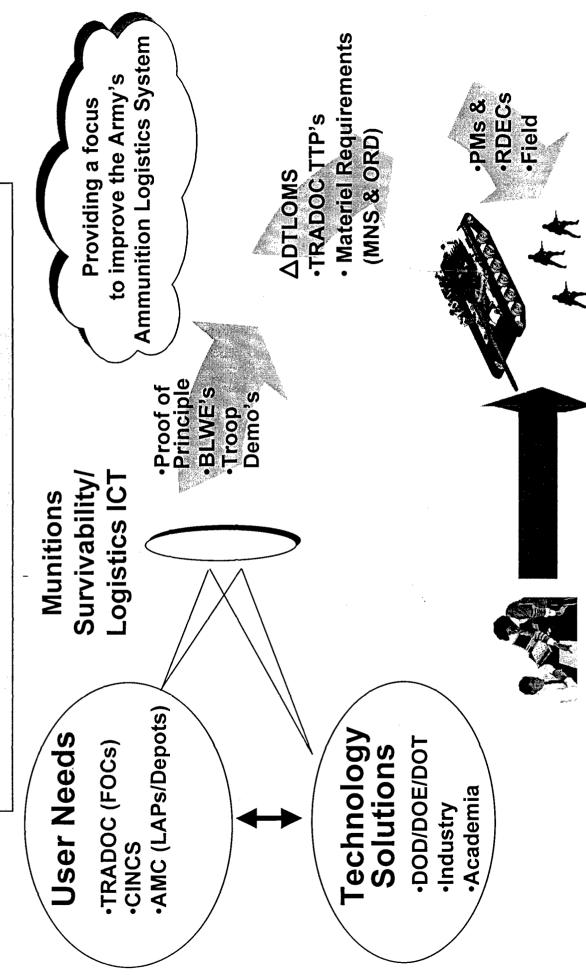
MISSION: Provide integration of the "lab to gun" overwhelming firepower for decisive victory. ammunition logistics system enabling

THRUST AREAS



- Reduce weapon system rearm times
- Apply state-of-the-art technologies to ammunition packaging
- Enhance explosives safety
- Manage Army Insensitive Munitions Program
- Manage Army HERO Certification Program
- Improve Logistics C⁴ Information for Ammo
- Improve strategic and battlefield distribution

What AMMOLOG Does

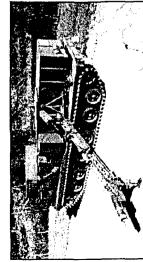


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"Lab to Gun" Ammunition Logistics System Integration

Examples of AMMOLOG's Impact on the Army

Battlefield Rearm



Artillery Rearm Module (ARM) II **Technology Transitioned** to CRUSADER

Explosives Safety

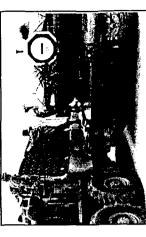


360 ft Hazard Zone Used in Bosnia and Haiti Ammo in MILVANs TDP 1200 ft |

Logistics C4 for Ammo

CD-ROM

Ammunition Packaging



Net Savings = \$17M thru FY96 M1A1 Tank Ammo Packaging 13 Min Reload 33

Combat Service Support





Container Handling Unit & CROP PLS Enhancements - M1 flatrack, Fielded Worldwide

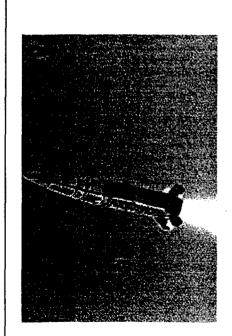
Over 400 Fielded Worldwide + 650 planned with SAAS-MOD

Information System (ASIS) **Ammunition Surveillance**

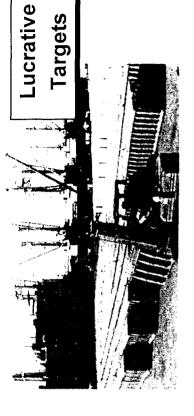
Doing what needs to be done for the Army

Defining the Munitions Survivability Problem

OPFOR Has Capability and Intent to Destroy munitions at Insertion Points



- Space & Resource Constraints Lead to High Density of Munitions
- Munitions Nodes Are Not Survivable









Potential loss of critical "preferred" munitions

Quickly Lead to Shortages of "Preferred" Munitions Destruction of a Munitions Logistics Node Can

Challenges of Future Warfare:

- Short, quickly decided battles
- Reduced logistics tail
- Just in time delivery
- Enemy access to smart munitions

1 1/2 containers of SADARMs is the total basic load for one Field Artillery Battalion



Munitions	Approx	Approx
	Army	Unit Cost
	Acquisition	u
	Objective	
SADARM	50K	\$39K
PGMM	28K	\$20K
WAM	33K	\$50K
THAAD	ㅊ	\$1M
ATACMS/BAT	1.5K	\$750K
JAVELIN	17K	\$145K

Bottom Line - Cannot afford to lose critical "preferred" munitions

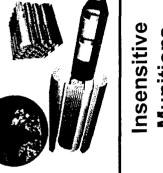
"Preferred" Munitions

Munitions Survivability & Logistics (RDTE 6.6)



Ammo Provider

and Protect Ammo Storage Areas Through Technologies Which Increase Distribution Velocity Munitions Logistics System Assure a Survivable



Munitions

Design Munitions Which Are Resistant to Fire, Fragment, Bullets, and Adjacent Munition Reactions



Develop Packaging With New Materials Designs, and Embedded Sensors

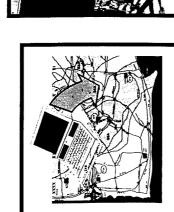
system. Together these projects can dramatically "This program incorporates a number of smaller enhance the logistical force protection structure projects that are often lost in the acquisition for critical munitions assets."

LTG John G. Coburn, Deputy Chief of Staff for Logistics, 28 Feb 97

Ammo Provider Program

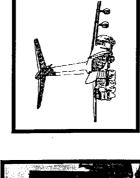
Project Objective:

To protect critical munitions supplies through improved ammo distribution velocity and ammo storage area survivability

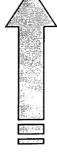


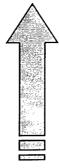
Munitions Survivability Software

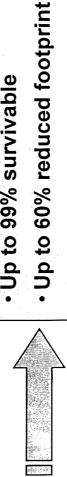
Strategic Configured Load Compatibility

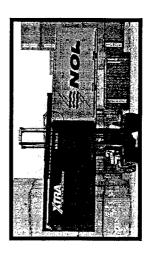


Airmobile PLS Flatrack





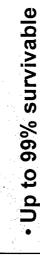




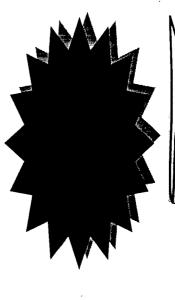
Containerlink

Handling Equipment

Automated Materials



Seamless ammo distribution



Munitions Survivability for the Army of the 21st Century

Army Insensitive Munitions Integration Program

Objective:

Develop, demonstrate, and implement technologies that reduce the vulnerability of munitions to unplanned stimuli.





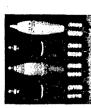


Approach:

- Assess IM status of Army munitions (Net Assessment)
- · Munition database of tests performed and results
- Assess IM technologies (Tech Assessment)
- Worldwide research- chemistry; energetics manufacture; insulating, shielding materials; vulnerability design characteristics
- Select appropriate technologies and prioritize munitions. Selection criteria:
- Can leverage results of development to many items
- Munition has joint use potential
- Collateral damage is catastrophic if not insensitive
- Critical munition Preferred munition, limited quantity, impact on war









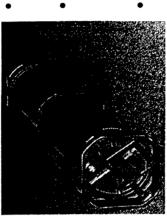
Improved Ammo Packaging

Advanced Container



- Reduced Life Cycle Cost:
- Reduced weight - Reduced cube
- Longer shelf life
- Reduced cost

Thermal Protection



- Reduced Thermal Loading
 - Avoid Ammo Performance DegradationEnhanced Ammo

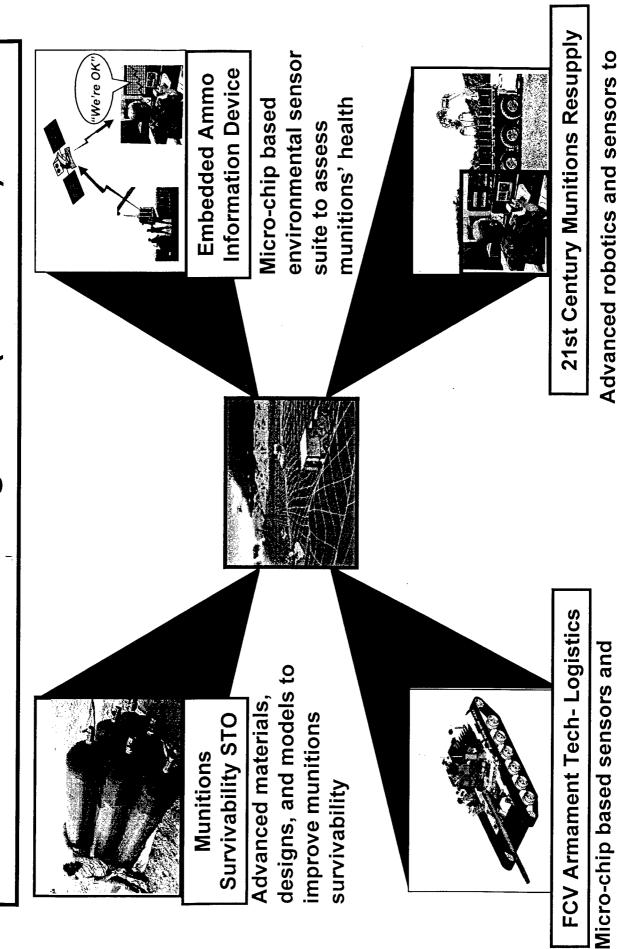
Reliability

Cheap Ammo Insurance $\,30$ Years @ 1-2 % of Item Cost



25.0

Ammunition Logistics (RDTE 6.3)



d S

autorearm to reduce logistics for AAN

build tailored munitions packages

Munitions Survivability STO III.0.19

Description

Develop and demonstrate advanced materials, designs, and predictive models to improve the survivability of deployed munitions supplies from projected threats

Benefits

- Limits ammo loss to only 1% from a direct hit
- 60% Reduced Ammo Storage Size
- 60-90% Reduced Stack Separation Distance







Rapid Barricades

Technologies

- Advanced Explosive Mitigation Materials
- High Performance Fire Blocking Materials
- Sympathetic Detonation Criteria for Army Munitions
- Firebrand and Fragment Propagation Algorithm Development

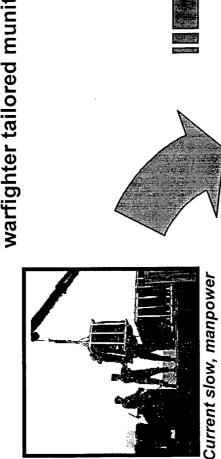
Predictive Algorithms

Protects from "sympathetic detonations of ammunition stores" **TRADOC Future Operational Capability TR 97-033**

21st Century Munitions Resupply System

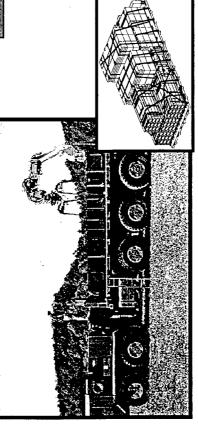
Project Objective:

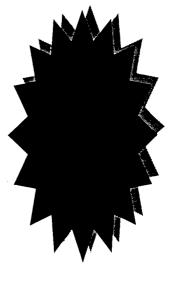
To provide robotics, sensors, and modular ammo packaging technologies to help Modular Ammo Platoons rapidly build warfighter tailored munitions packages





intensive process





Sample concept - will investigate several technology options

Focused Logistics Support for the Army of the 21st Century

Embedded Ammo Information Device

Joint TACOM-ARDEC/MRDEC Remote Readiness Asset Prognostic/Diagnostic System Proposed STO

Description

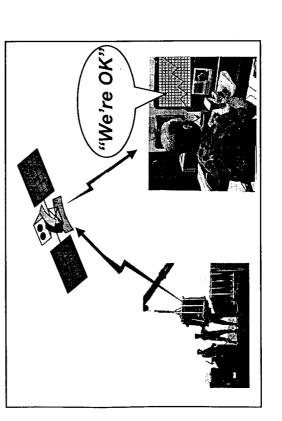
Demonstrate an active microchipbased environmental sensor suite to measure temperature, barometric pressure, humidity, corrosive environments, and extreme shock events and assess the health and condition of munitions

Benefits

- Supports real-time munitions diagnostics and prognostics, reducing the logistics tail
- Provides data for anticipatory maintenance to accurately plan requirements and prevent cascading equipment degradation
- Enables predictive readiness assessment to increase the probability of mission success and prevent the unnecessary loss of critical assets

Technologies

- Micro-Miniature RF microchip
- Integrated MEM sensor suite for environmental data capture
- Novel on-board power management system to ensure long life (20+ years)







Future Combat Vehicle Armament Tech for AAN Logistics

FCV Armament Technology for AAN Proposed STO

Description

Demonstrate a passive micro-chip based sensor to provide temperature data to optimize Electo-Thermal Chemical (ETC) gun performance and provide logistics data. Develop concepts for "plug-in" modular packaging and auto-rearm capability

Benefits

- Provides instant temperature and logistics data to optimize ETC gun performance and increase lethality
- Provides Total Asset Visibility (TAV) at the individual cartridge level
- Automated ammo package handling provides rapid "plug-in" FCV rearm
- Modular ammo packaging of advanced composite materials provides reduced weight and cube

1 cm sensor

Technologies

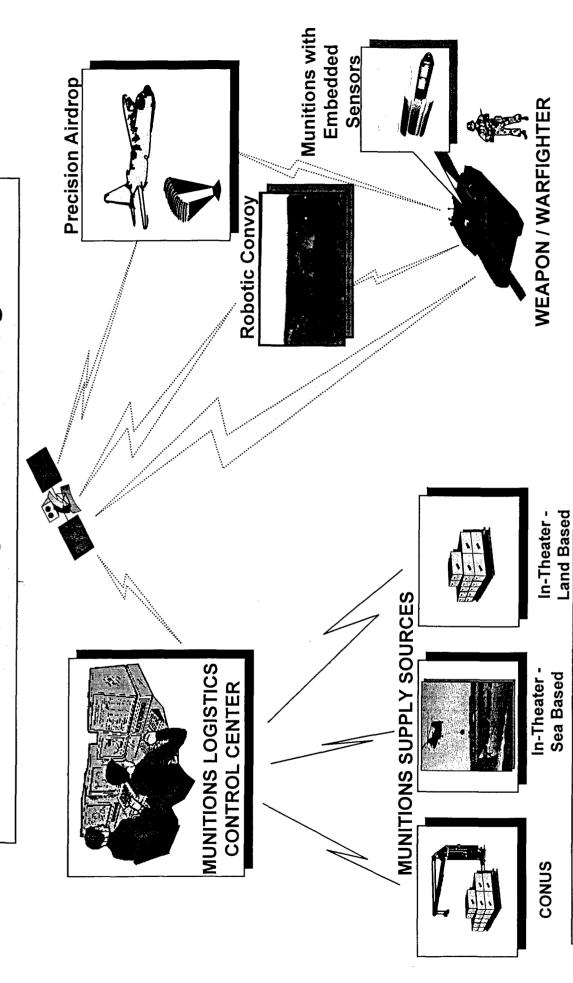
- **MEMs sensors**
- Robotic ammo handling system
- Modular ammo packaging concepts
- Advanced composite materials







AAN Anticipatory Munitions Logistics



Weapon - Munitions Information Transmitted:

•Weapon Location

•Weapon Consumption

•Resupply Request

Supply - Munitions Information Transmitted:

· Environmental Data

·Location ·Quantity

- We provide integration of the "Lab to Gun" **Ammunition Logistics System**
- · Our programs directly support "Ammo XXI" the TRADOC Force XXI Concept for Ammunition Logistics

Remember: When your ammo blows up - it's gone! Bottom Line: You can't fax ammo to the battlefield



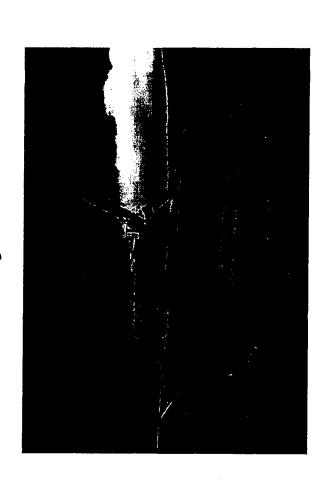




Mobility and Firepower for America's Army

Army XXI

Mortars for Mounted Maneuver:



Peter Burke OPM Mortars

Tank-automotive & Armaments COMmand Committed to Excellence

550

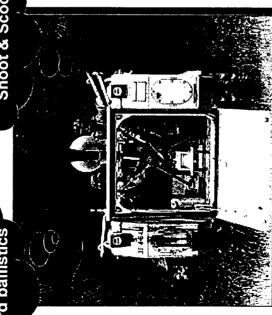
Purpose/Agenda

- Discuss mortar directions for mounted warfare to 2010 and beyond
- M1064A3 with Mortar Fire Control System
- Turreted Mortar
- Ammunition Upgrades
- Precision Guided Mortar Munition
- Extended Range DPICM
- Dragon Fire
- Mobile Dragon
- Summary

M1064A3 w/Mortar Fire Control System

Responsiveness: Increased

Shoot & Scoot Survivabilit



Information Dominance

Performance:

- Pointing accuracy: 3 mil
- Ballistic calculation: Under 10 seconds
- Position accuracy: 10 meter CEP
- Digital Communications
- Automatic MET updates
- Automatic position reporting
- **Embedded training**
- First round out: Less than 1 minute
- 3-4 rounds per mission
- O-1 Adjust, 3 Fire For Effect (FFE)

Program Status

- Engineering & Manufacturing Development
- Production start in 00

First Round Out

Warrior Focus NTC 94-07 Current

Focused Dispatch

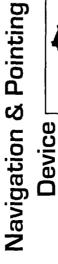
Demonstrated performance: Integrated digital on-board fire control for mortars



MFCS Components

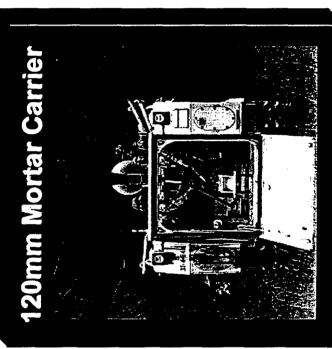


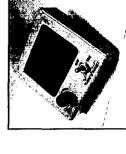
Digital & Voice Communications SINCGARS SIP, EPLRS



Tube Mounted

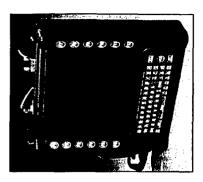






Driver's Display

Guide to Azimuth of Fire Navigation Aid



Commander's Interface (CI)

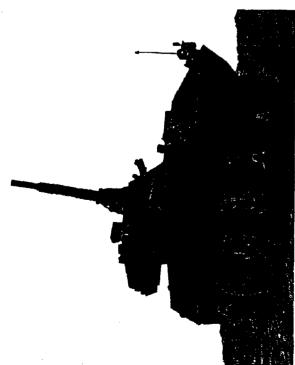
Automatic Ballistic Computations Digital Interface with Tactical Internet for Situational Awareness & AFATDS

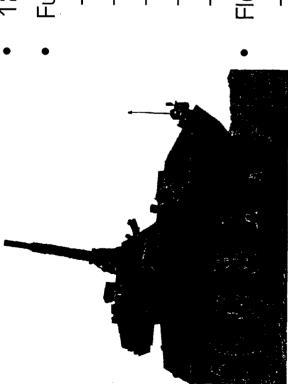
Gunner's Display Replaces Optical Sight Digitally Linked to Pointing

Device & CI Improved Gun Laying Procedure



SANG Turreted Mortar



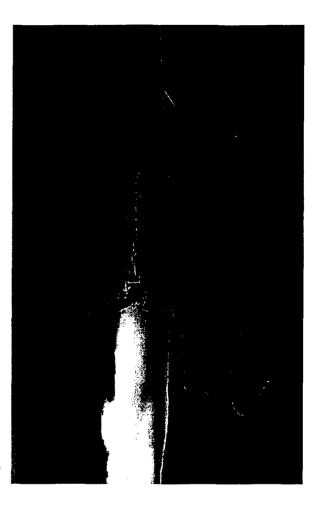




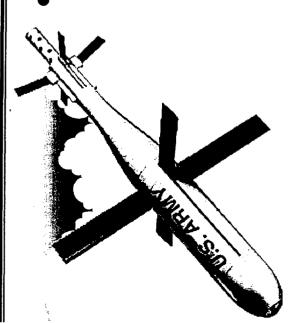
- 120mm breech loaded smooth bore
- Fully integrated fire control
- Autolay
- Digital communications
- **Thermal sight**
- Laser rangefinder
- GPS pointing and navigation
- Flexible weapon system
- Indirect fire (high and low angle)
- Direct fire
- Ammunition range of 9200 meters
- Compatible with future ammo
- Longer tube extends range
- Currently being qualified on the LAV at Yuma **Proving Ground**
- Limited technical assessment conducted by JSMC Warfighting Lab at 29 Palms

Mortar Turret on M113

- SANG LAV turret and other mortar turrets have been integrated on the M113 chassis
- Firing demonstrations conducted for Middle Eastern countries
- USAIC plans to convert some M1064A3s to turreted mortars after 2010
- Development funded in extended plan for 07 start
- Other chassis can be considered, from the Bradley to the Future Combat Vehicle



Key Ammunition Upgrades



- Precision Guided Mortar Munition
- Laser guided 120mm projectile
- Extended range using glide concept
- ATD completion in 01
- EMD start in 02



- Tractor rocket motor
- Embedded multi-functional fuzing
- Currently demonstrating components in tech base



Precision Guided Mortar Munition

Task Force Commander's Precision Indirect Fire Weapon

GPS Guidance Destroy Acquire Glide Platform: M120 & M121 No additional force Range: 12-15 km Mortar System structure

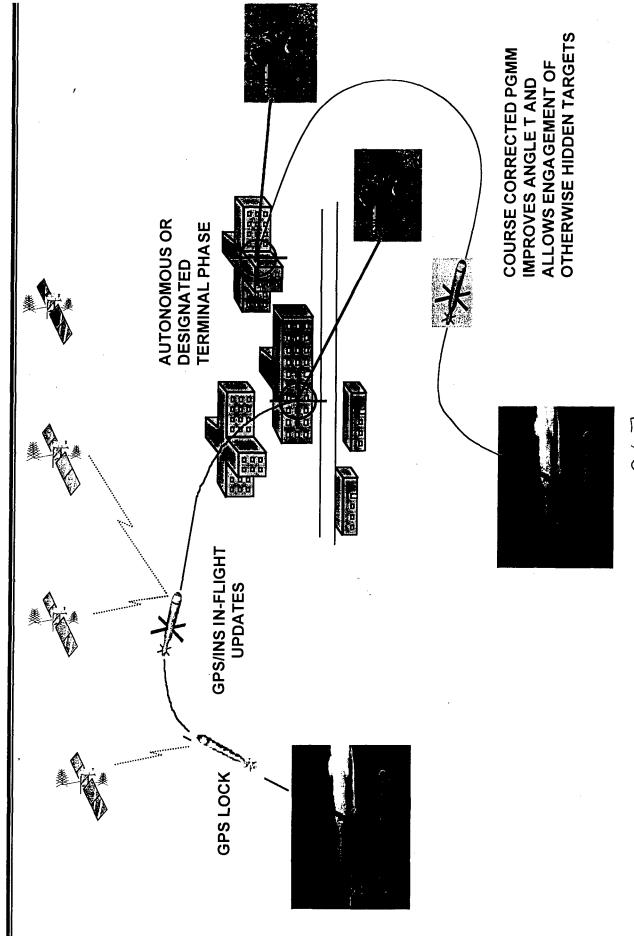
120mm Mortar with MFCS is more **Responsive**

LLDR and Striker *Pinpoint* and *Designate* Leverages other programs for Total System Improvement

PGMM **destroys** bunkers, structures, MOUT targets with low collateral damage.

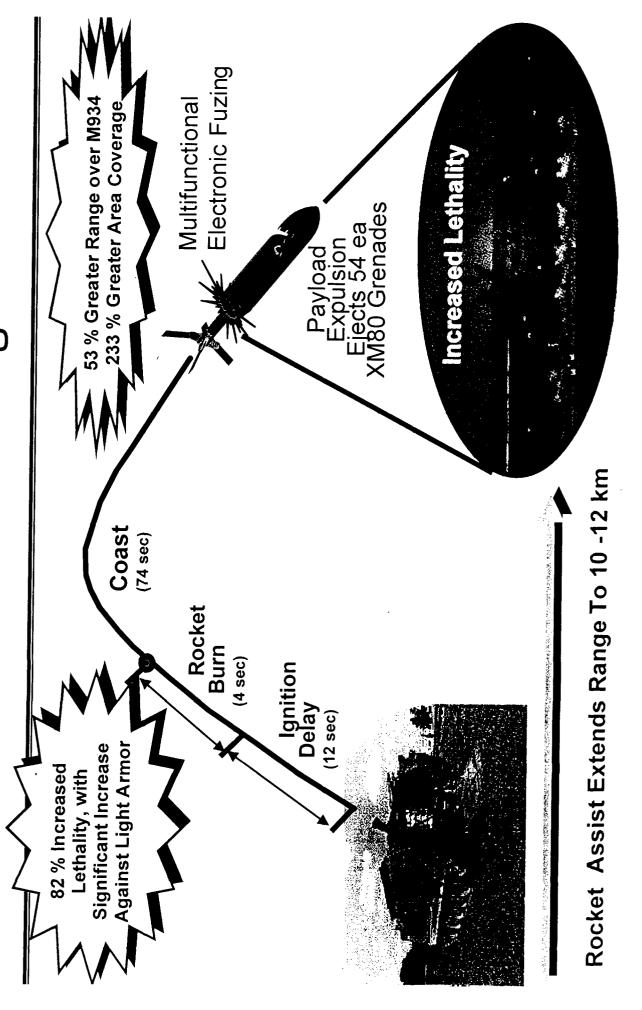
2000

PGMM Upgrade: In-flight Course Correction



707

XM984 Extended Range DPICM



3C8

USMC Warfighting Lab Initiatives



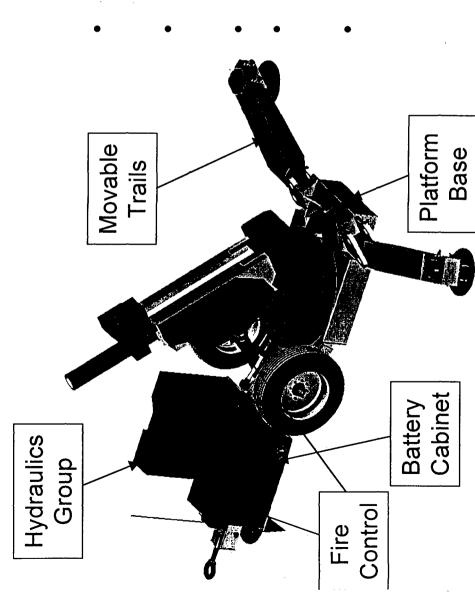
Dragon Fire

- Unmanned 120mm mortar
- Early concept in Hunter Warrior AWE
- Technical demonstration in Sep 98
- Included in Urban Warrior AWE

Mobile Dragon

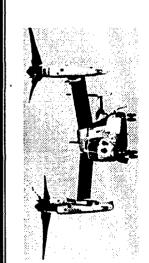
- Early concept spinoff from Dragon Fire
- Automated fire for the heavy maneuver forces

USMC Dragon Fire



- Emplaced by MV-22 Osprey, helicopter, air foil, HMMWV
- Deploy systems near & forward of the FLOT
- Receive digital calls for fire Conduct operations autonomously
- Reloaded, recovered or abandoned
- anti-tamper capability

Dragon Fire Operational Concept



 Inserted by MV-22 Osprey, crew installed within 2 minutes 3. FO with TLDHS sends

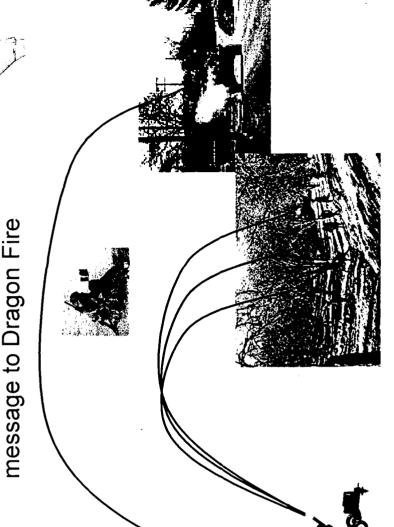
digital call for fire

3. UAV detects target and sends information directly to Dragon Fire

 Dragon Fire maintains a low visual and power profile until alerted



4. Dragon Fire automatically executes mission with selected round from mortar suite of ammunition, including PGMM

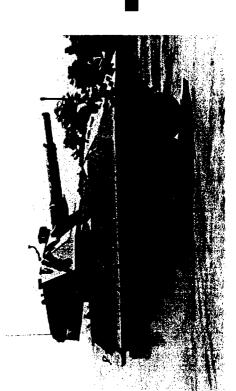


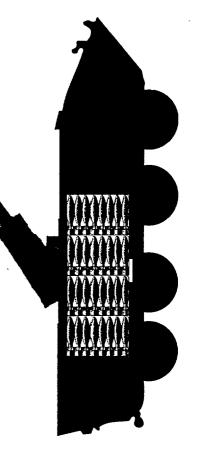
ころ

USMC Mobile Dragon



- Driver only or possibly a commander
- Automated response to calls for fire
- ·Fire on the move
- Replace crew stations with
- additional ammo storage capability
- ·High mobility maintains pace of future battlefield

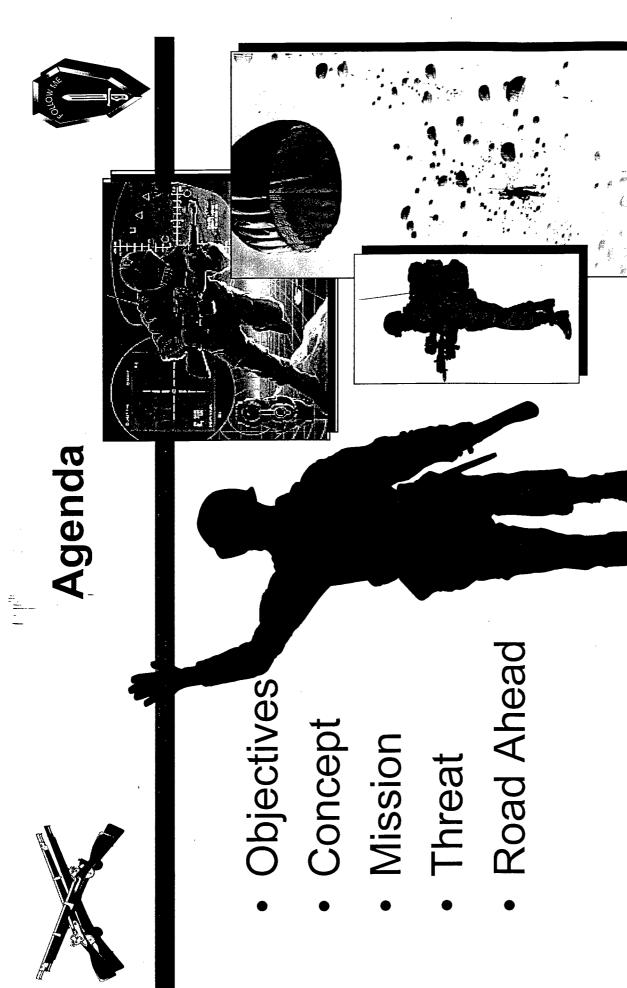




Mounted Mortars for XXI

- M1064A3 with MFCS provides a growth platform
- Smaller logistics tail [PGMM, DPICM]
- Massed fires
- Multiple Rounds Single Impact
- Supplemental automated guns
- Versatile
- Indirect and direct fire
- Extensive suite of munitions
- Mortars proximity to each other no longer required
- High OPTEMPO
- Responsive fires with mortar fire control improvements
- Fire on the move







Light Infantry 2010 Objectives



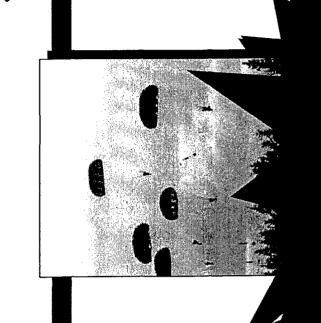


Global maneuve

• Information domina

Improved survivabi Improved lethality Improved accuracy

Improved soldier loa (weight versus capa







Light Infantry Concept



- Light Infantry forc
- Strategic and o rations
 of Ranger, Light,
 & Air Assault Forces
- Tactical mobility focus firepower & survivability
- Maintain capability to will
- Overwhelm enemy forces Increase precision firepov
- Fight jointly & combined w
- **LCONUS** based force) Operate with extended log



in restricted terrain

- close fight & hold ground ut range the enemy
- n o er services

Premise



me an elemy's will, close with and he must know tha To influence an destroy him

nt factors in the close dwer, and shock effect remain predl Overwhelming Ma fight

% [d



Assumptions



- Information dominance enables precision maneuver & targeting
- endent upon speed and Operational success mobility
- Decisions assured wit
- Support platforms ad

bed of deployment

if not real time

- s risk and begins process of psychological domit Being "first with the m
- tary Operations on Urban ı Terrain (MOUT) focus inc Extended urban condition
- nower requirements Increased digitization = ip



Light Infantry Mission



e combat, and er to defeat or emy by means p repel his ttack Cour of fire and ma assault by fire capture hi Close with





Light Infantry Threat



- third world countries has nment -- THREAT amo replaced bipolar Cold Multi-polar compet
- lened from a European OYMENTS 1 focus to worldwide in sca U.S. security objectives h
- non-state threats have e Rogue state military, bar
- some groups -- NEED FO international market has c Increased availability of a

we apons and technology on an asymmetric advantage for narco-criminal and other URVEILLANCE CE PROTECTION]



The Road Ahead



Infantryman = La Warrior:

More lethal

More survivable

More mobile

Improved situation aw

 C_2

Communication link t

Digital comm links to a Near perfect intelligen

Near perfect intelligen

Sensor shooter linkage

Digital links to all combCombat Identification

en

e s poort assets e -- s tuational awareness

vel les and Land Warriors





(Future Weapon Systems)



Mortars

- Quicker respo

- Increased lethality

- Increased survivability

Increased range

Lighter

- Infrared Illumination

Antiarmor Family

- Increased range

- Increased lethality

- Increased survivability
(NLOS/Fire and Forget)

MOUT capabilityLighter





The Road Ahead (Future Weapon Systems)



- Soldier Moderniz ion Family
- Soldier as a sy.
- More lethal
- More survivable
- Lighter loads
- Digital comms
- Non-lethal program

- Own the Night Family
- Enhanced vision through sensor fusion
- Increased accuracy
 through integrated laser
 range finder/pointer
- Improved survivability through combat ID

Integrated into digital





T80



The Road Ahead (Future Weapon Systems)



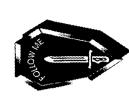
- Directed Energy
- Pending gove
- Low observable la
- Electro-magnetic gun

- Micro Robotics
- Improved unmanned surveillance/recon
- Enhanced soldier survivability
- Sees across visible and seismic spectrum
- Tied into digital battlefield





Conclusions



- Revolutionary
- Digital Communic
- Doctrine
- **Evolutionary Cha**
- Munitions
- Capabilities
- Survivability





Night Vision/Reconnaissance, Surveillance, Office of the Project Manager and Target Acquisition

Armaments for the Army of the Future Symposium and Exhibition Presented by: COL Jeffrey A. Sorenson Project Manager

Project Manager 23 June 1998

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ii · —



FY98 Organization

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CIV 119 MIL 37

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JPSD

CISS

Sentinel

Combat ID

NV/RSTA

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28 K



Project Manager - Night Vision/Reconnaissance, Surveillance, and Target Acquisition





Chartered Programs



PROJECT MANAGER

Night Vision / Reconnaissance, Surveillance and Target Acquisition (PM NV/RSTA)

ser/Sens

official, provide overall direction and guidance for mprovements and fielding of assigned programs, vstems, Electro-Optical Countermeasure System Programs, associated unique test equipment, and Aperture Radar Payloads, Image Intensification the systems integration of relevant multi-sensor the development, acquisition, testing, product Hosted Moving Target Indicator/Synthetic Programs, Laser Programs, Electro-Optical .. You will, as the responsible management to include Infrared Capabilities, Thermal

Integration opportunities... and interoperability Responsible for... Horizontal Technology

Radar

Intelligence, Electronic Warfare, and Sensors Program Executive Officer

Thermal









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IEW85 PROGRAM EXECUTIVE OFFICE

PM NV/RSTA Army Customers















Fort Knox, KY



Fort Sill, ok

Fort Buckey, AL



Fort Huachusa, A.B.





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I=WaS Technology & Systems Changing the Face of the Battlefield

OWN THE NIGHT See

Know The Enemy

Hear

当HL NMO SPECTRUN

Disrupt

Offensive Control

Deny

SPECTRUM HEL NAO

Communications

Seamless

Out Think

Digitize the

Communicate

Battlefield

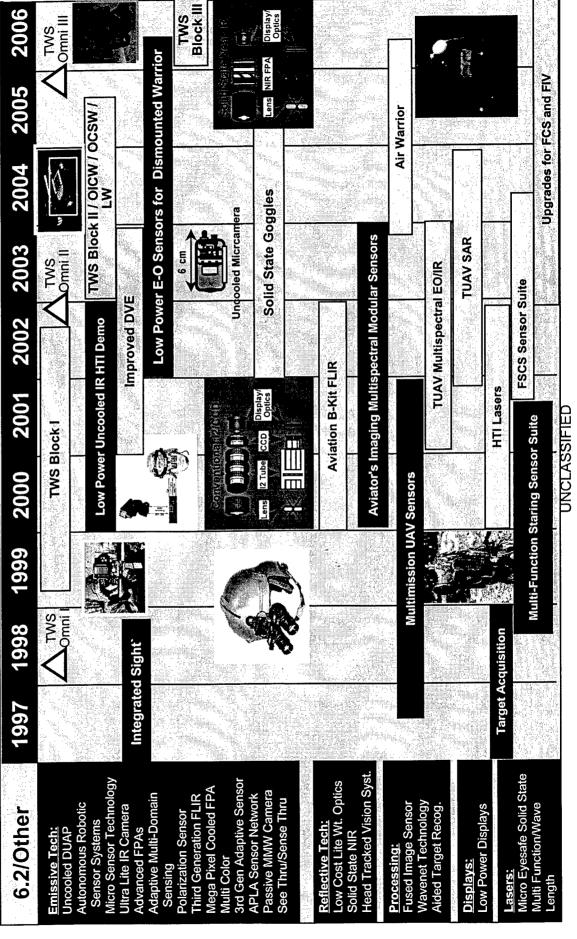
(Defensive Control)

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S&T Transition Plans





IEW&S

12 Devices - Night Vision Goggles



(NAG)

Capabilities Sensor Fusion FUE: FY05 Extends the Battlespace for FORCE PROTECTION 245m 360m Sensor INCREASE 280% Desert Storm Current

****** = 10000 systems

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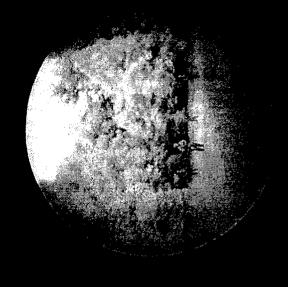
15 W&S Increased Brightness & Image Clarity NWRSTA Omni IV Gen III Gives



PERFORMANCE COMPARISONS

Clear Starlight Conditions $(\sim 10^{-4}fc)$





Omnibus IV Gen III

Omnibus II Gen III

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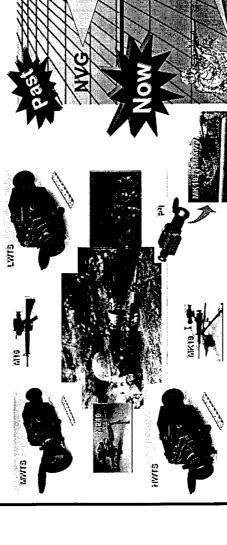
とのは



Thermal Weapon Sight (TWS)



Brings the Darkness Into Focus - The Soldiers **Night Eyes for PRECISION ENGAGEMENT**



Dismounted/Mounted Applications

		Objective	We	
	Range	Weight FO	FOV	
MTS	250m	3.0 lbs	27°	
WTS	1100m	4.5 lbs	တိ	:
WTS	2200m	5.0 lbs	°4	and the property of the

Now Lives 1,100m 2,200m 2,200m 2,200m

FUE: FY98

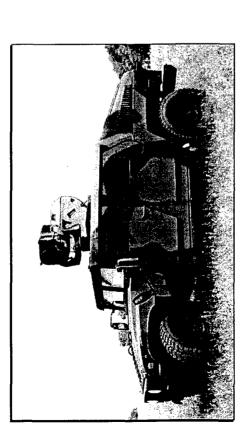
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Long Range Scout Surveillance System (LRAS3)



HMMWV Mounted



Key Performance Parameters

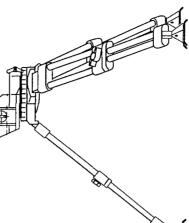
- ➤ Long Range Target Acquisition
- ➤ Far Target Location
- ➤ System Weight
- ➤ FBCB2 Interface
- ➤ Dismounted Operations

Dismounted Tripod



➤ Rechargeable Batteries

➤ Vehicle Battery Charger



FUE: FY01

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Picture through 2nd Gen FLIR

Lightweight Laser Designator Rangefinder (LLDR)





G/VLLD and Night Sight Weight - 109 lbs

 No Digital Target Hand-off Capability



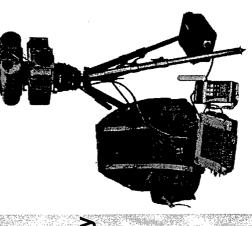
Key Performance Parameters

- ➤ Total System Weight <35 lbs
- ➤ Target Recognition 6 km (day)
 2 km (night)
- Laser Designation 5 km (stationary)3 km (moving)
- ➤ Target Location Accuracy 80 m CEP @ 9,995 m
- ➤ Eyesafe Rangefinder Up to 10 km

System Description

- **→ Joint Army/ USMC EMD Program**
- Mission Configurable Modular Design (2-man portable)
- ➤ "See Spot" Boresight Capbilities
- ➤ Embedded GPS
- ➤ 640 x 480 FLIR
- ➤ Digital Target Hand-off Capability





FUE: FYO.

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Lightweight Video Reconnaissance System (LVRS)



Extends the Battlespace for FORCE PROTECTION Widens the Safety Zone for Recon Soldiers





Base Station

➤ Manportable

➤ Near *REAL TIME* Imagery

Target Data Dissemination

Night - 500m

• Day - 1.5km

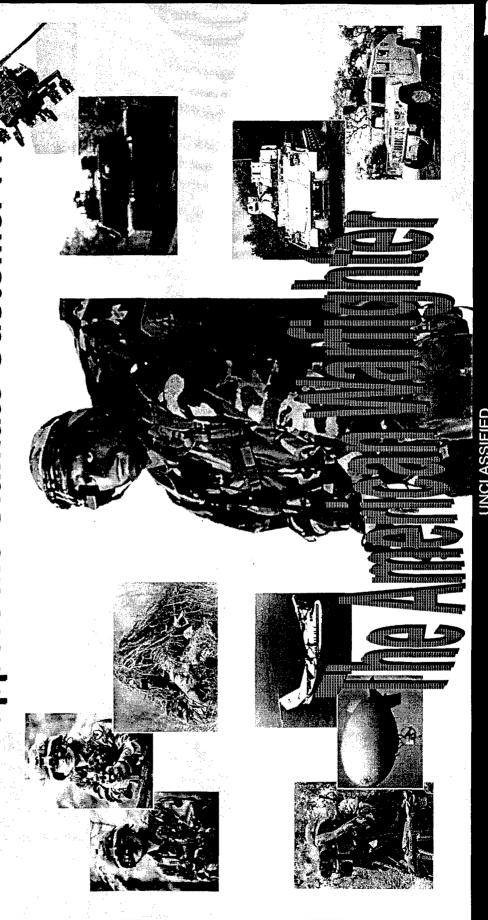
FUE: FY98

Out Station

2 3 g UNCLASSIFIED



Project Manager Night Vision / Reconnaissance, Surveillance and Target Acquisition Support the Ultimate Customer PM-NV/RSTA Products. IEW85 PROGRAM EXECUTIVE OFFICE





/ACOM

Mobility and Firepower for America's Army



NDIA Armaments for the Army of the Future

An International Symposium & Exhibition

June 23 - 24, 1998

Parsippany, NJ

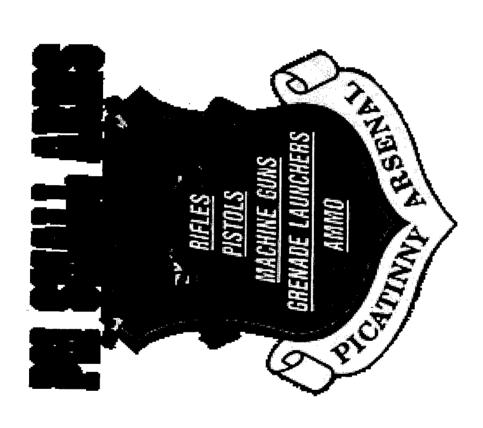


PACSMAIL Arms

Tank-automotive & Armaments COMmand Committed to Excellence



TACOM



Committed to Excellence



NOISSIM

- Centralized life cycle program management of all assigned Army small arms weapon systems.
- Individual and Crew Served Weapons
- Grenades/Grenade Launchers
- Mounts/Tripods
- Ammunition
- Fire Control/Optics

Committed to Excellence

SMALL ARMS DIRECTION

1990

EXISTING WEAPONS M2 MG (1923)

M16 Rifle

M60 MG

M4 Carbine MK19 GMG M24 Sniper Rifle **M249 SAW**

M9/M11 Pistols

25 SMALL ARMS IMPROVEMENT PROGRAMS

Modular Weapon System Weapon Upgrades

Optics/Fire Control

Suppressors, Adapters Mounts/Tripods

Equipment Packs/Magazines Buttstocks

16 NEW SYSTEM PROGRAMS

Ammo (AP, Non-Lethal, Multipurpose, SLAP) ·Tracers, Grenades

Mini/Stabilized Binoculars

Sniper Rifle

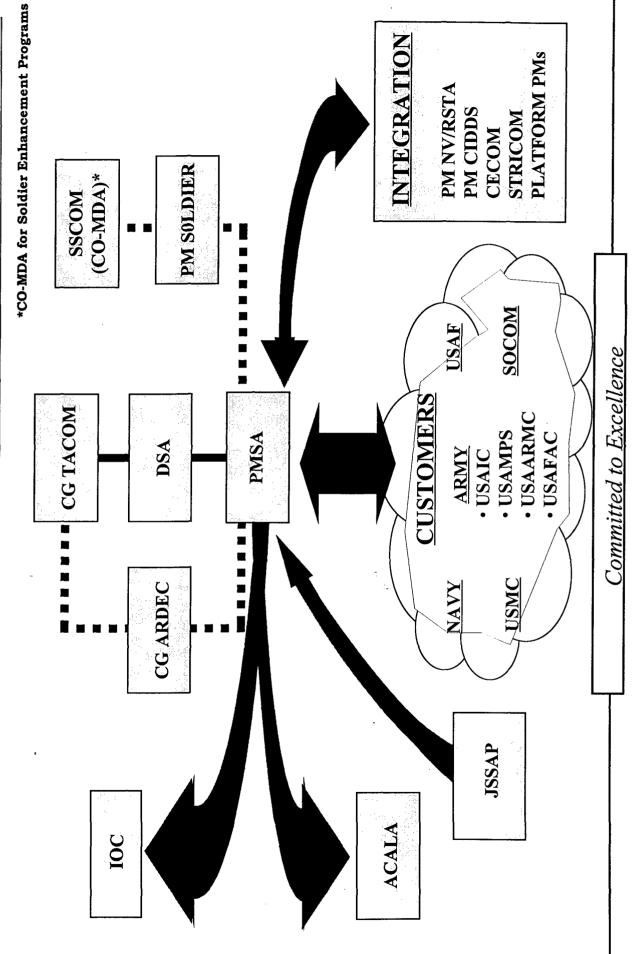
E

OBJ FAMILY OF WEAPONS

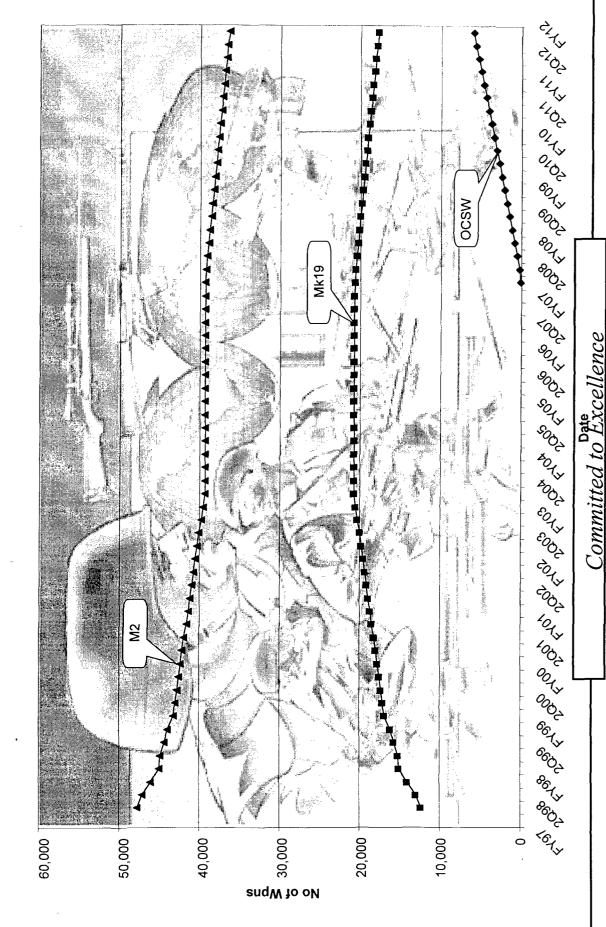
Individual Combat Personal Defense **Crew Served**

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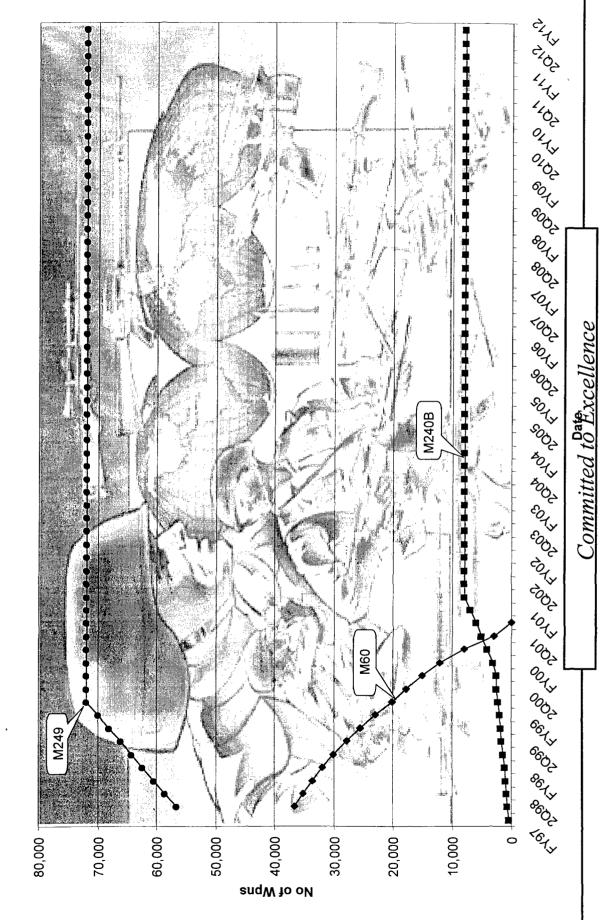
PMSA RELATIONSHIPS



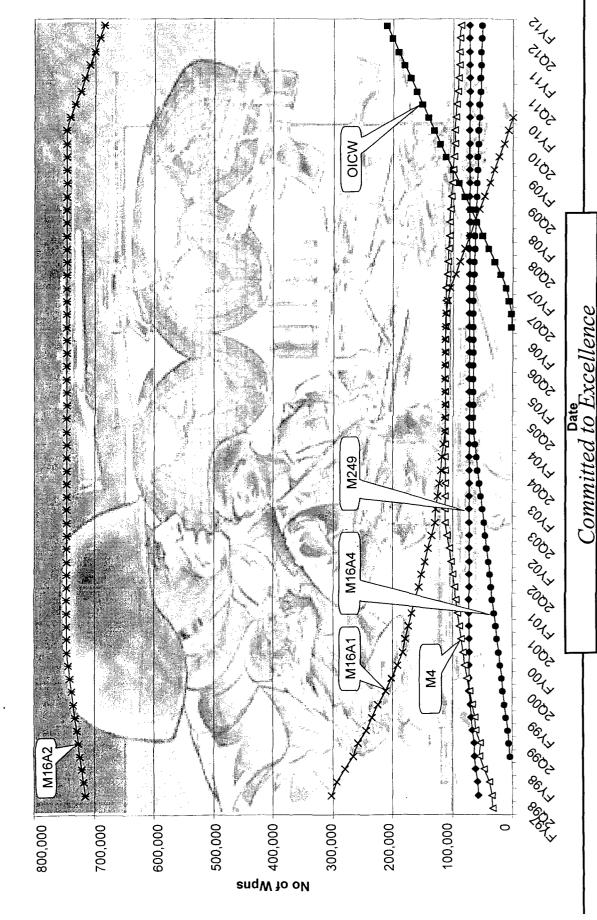
Heavy Weapons Fielding Status



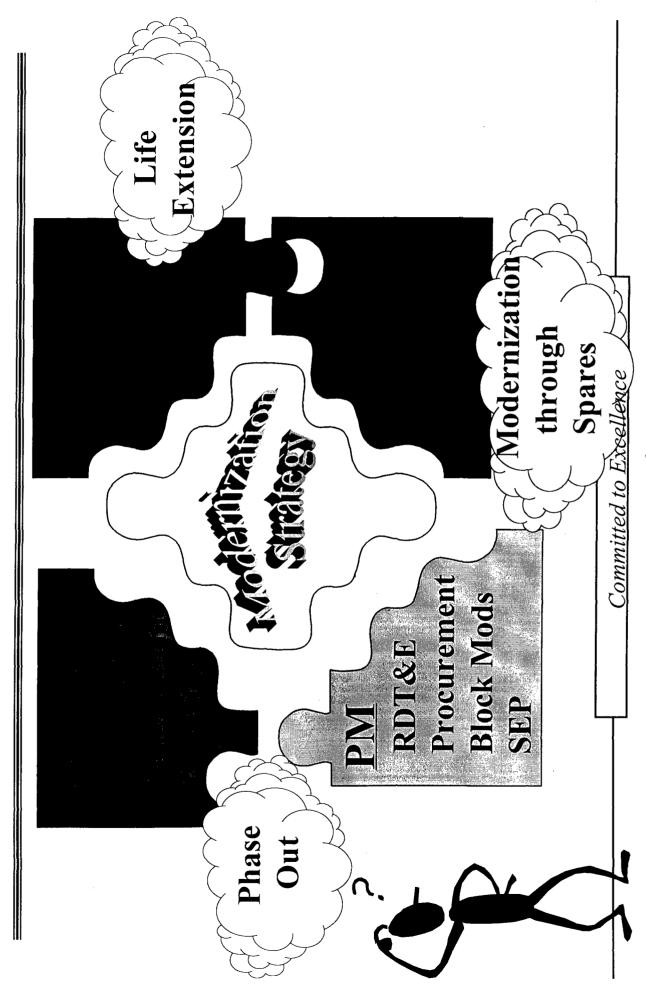
Med/Light MG Fielding Status



Individual Weapon's Fielding Status



SMALL ARMS STRATEGY



M16/M4/M203 INITIATIVES



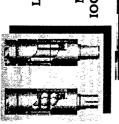
NON-LETHAL 40MM ROUND IOC: 3QFY99* IMPROVED BUTTSTOCK FOR M4

FUE: 1QFY99

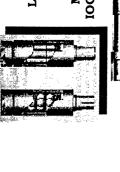


5.56 ARMOR PIERCING IOC: 3QFY98

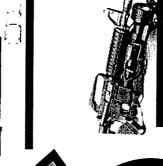
MUNITION LETHAL



IOC: 3QFY99 *



LAUNCHED

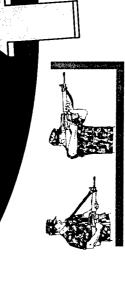


WEAPON FLASHLIGHT FUE: 4QFY99* MOUNT





M203/M4 COMPATIBILITY FUE: 3QFY98



SLING, CLOSE QUARTERS BATTLE FOR M4 FUE: 3QFY99*



MODULAR WEAPON SYSTEM **FUE: 40FY98**

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M249 SAW INITIATIVES

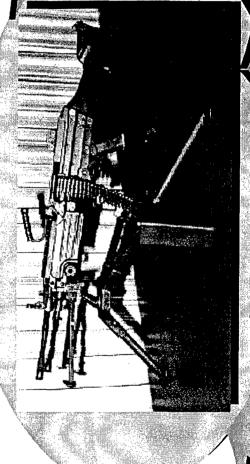


SHORT BARREL FUE: 2QFY00



HMMWV MOUNT FUE: 3Q FY98





COLLAPSIBLE BUTTSTOCK FUE: 4QFY97



MACHINEGUN OPTICS FUE: 3Q FY99

BLANK FIRING ADAPTOR FUE: MAY 95



FEED TRAY COVER FUE: 1Q FY99*

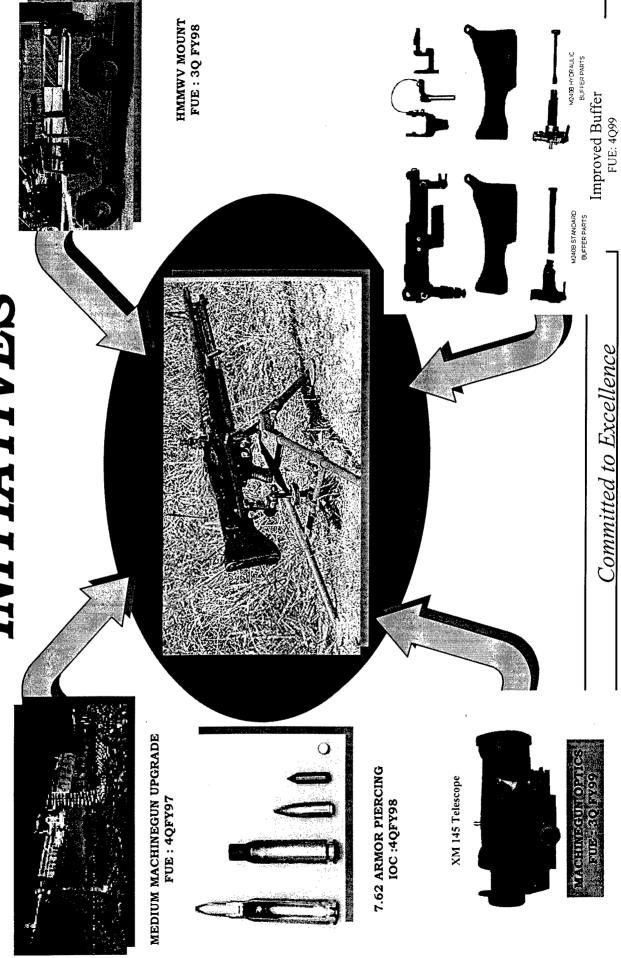


ASSAULT PACK FUE: 3Q FY98

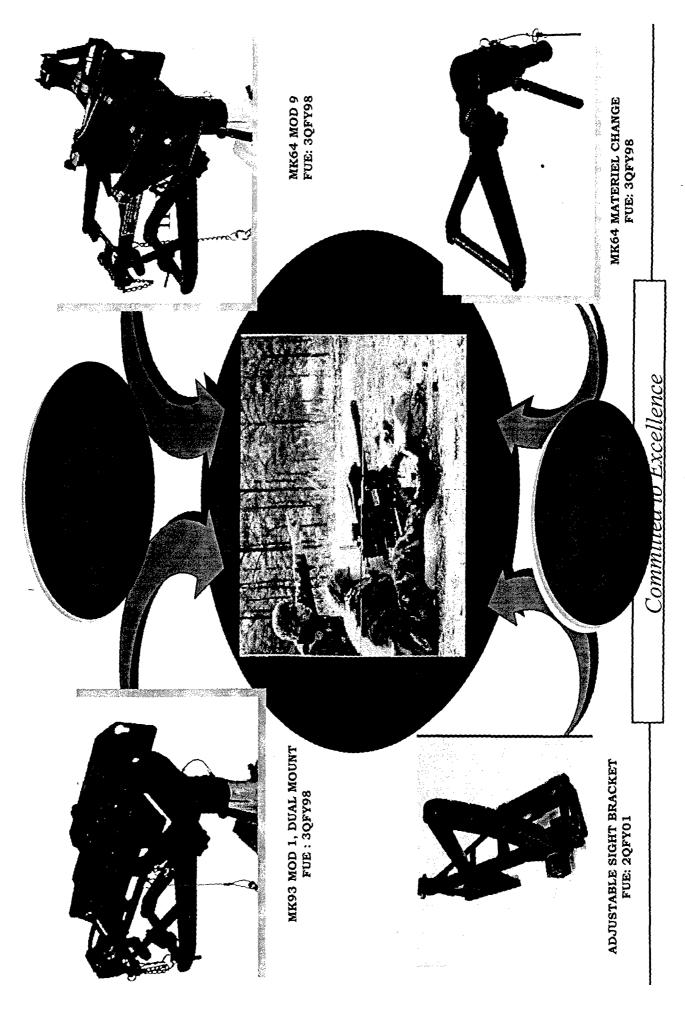
5.56 ARMOR PIERCING IOC: 4QFY98

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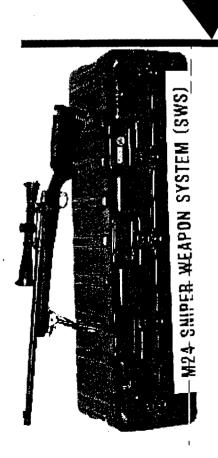
7.62 MACHINEGUN INITIATIVES



MK 19 GMG INITIATIVES



SMIPER WEAPON SYSTEM **INITIATIVES**





LONG RANGE SNIPER RIFLE



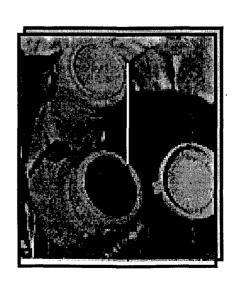
FLASH/BLAST ATTENUATOR FUE: 4Q FY97

XM144 STRAIGHT TELES FUE : JUL 96

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FIRE CONTROL



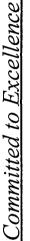






XM25, Stabilized Binoculars FUE: 2QFY99

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Product Manager Small Arms











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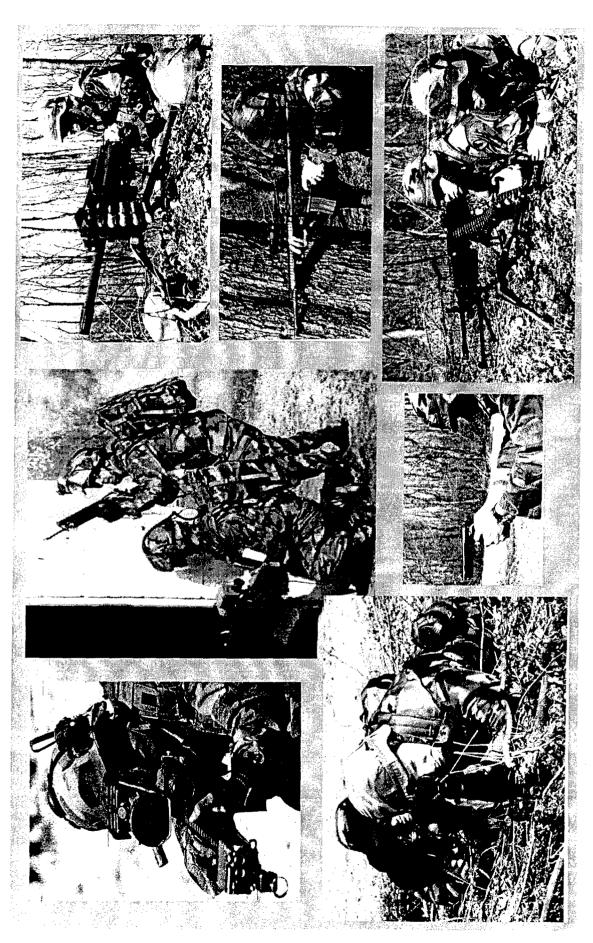
PROJECTED SOLICITATIONS FOR THE NEXT 12 MONTHS

TITLE	PROJECTED RELEASE DATE	PROJECTED AWARD DATE	TYPE
IR Illuminating Hand Grenade	May 98	Oct 98	R&D/Prod.
Back-Up Iron Sight	June 98	Aug 98	R&D/Prod.
MK64 Mod 9 Mount	June 98	Sept 98	Prod
Flashlight Bracket	June 98	Sept 98	R&D/Prod
M203 Enhanced Fire Control	Aug 98	Jan 99	R&D/Prod
Non Lethal 40mm Crowd Control	l Aug 98	Nov 98	R&D/Prod
M249 Barrel	Aug 98	Nov 98	Prod

PROJECTED SOLICITATIONS FOR THE NEXT 12 MONTHS

	PROJECTED	PROJECTED	
TITLE	RELEASE DATE	AWARD DATE	TYPE
40mm IR Illumination Cartridge	Sept 98	Jan 99	Prod
Improved MK19 Mount	Oct 98	Jan 99	R&D
12 Gauge Breaching	Dec 98	Apr 99	R&D
.50 Cal Long Range Sniper Cartridge	Jan 99	May 99	R&D
Medium Sniper	Feb 99	Feb 00	R&D/Prod
XM1006 Non-Lethal Ctg. (Sponge Grnd)	Feb 99	May 99	Prod
M203 Improved Accuracy	June 99	Oct 99	R&D
Light Weight Hand Grenade	June 99	Aug 99	R&D
	Committed to Excellence	cellence	

GIVING THE SOLDIER



THE FIREPOWER THEY NEED

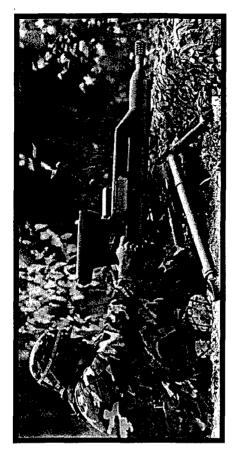
Committed to Excellence











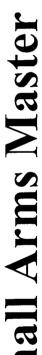
Vernon E. Shisler System Manager Objective Family Small Arms

U.S. Army ARDEC Joint Service Small Arms Program (JSSAP) Picatinny Arsenal, NJ 07806-5000 973-724-6009

Tank-automotive & Armaments COMmand Committed to Excellence

Small Arms Master Plan





















June 1998

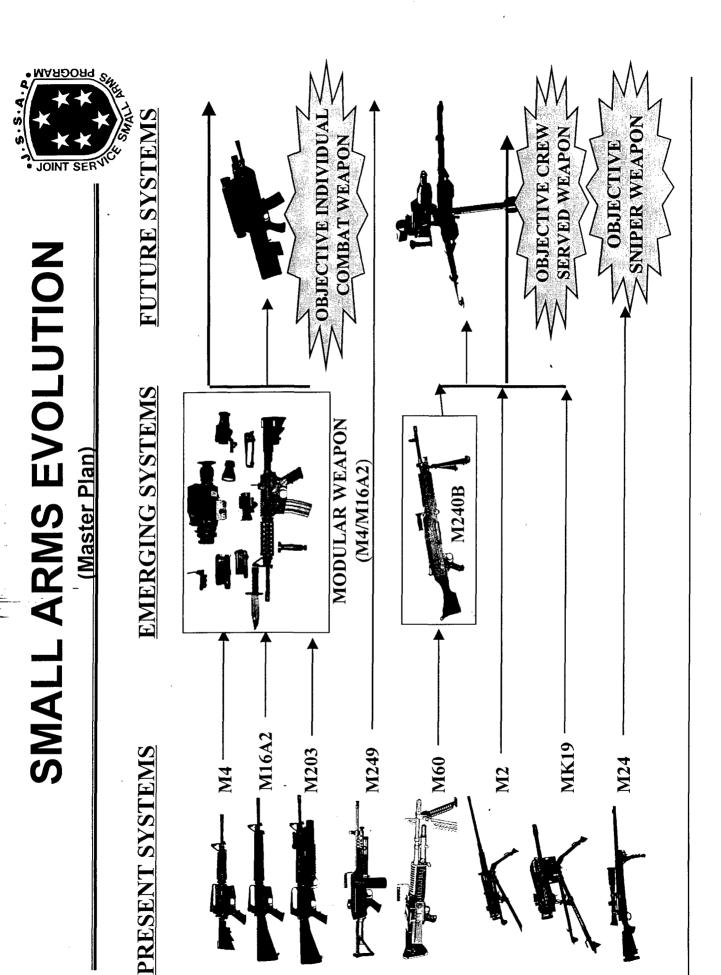


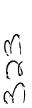
 Approved By All Services

Current Plans

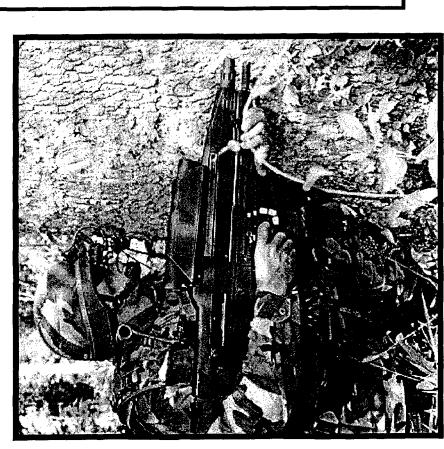
· Road Map to Future

Document Just Updated





Objective Individual Combat Weapon



Next Generation Individual Weapon

- · Replace Selected Rifles
- Lethality Upgrade to Land Warrior
- Troop Demonstrations
 FY99
- Transition to PM Small Arms FY00
- First Unit Equipped FY06

Objective Individua Combat Weapon



Concept

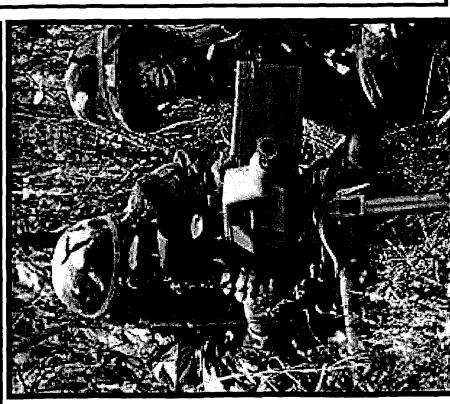
- Dual Munition Weapon 20mm Airbursting 5.56 mm KE
- · Separable Systems
- **Full Solution Fire Control**
- Defeats Targets the M16 Cannot
- Increased Stand-Off to 1000m

Contractor Team

- Alliant Techsystems
- · Heckler & Koch
- · Contraves Brashear

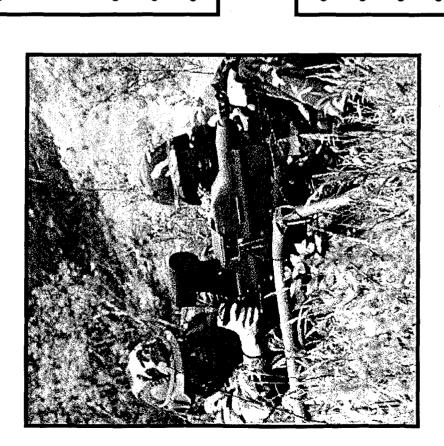


Objective Crew Served Weapon



- Next Generation Crew Served Weapon
- Replace Selected Medium
 Heavy Machine-Guns
- Lethality Connectivity to Land Warrior
- Troop Demonstrations FY01
- Transition to PM Small Arms FY02
- First Unit Equipped FY08

Objective Crew Served Weapon



Concept

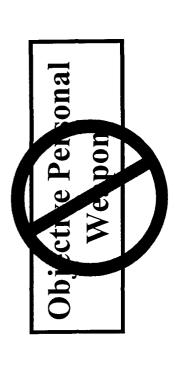
- Ultra-Light Two Man Portable
- Family of 25mm Munitions Air Bursting
 - Armor Penetration
- Defeats Defilade Targets
- Increased Survivability
- · Increased Kills / Combat Load

Contractor Team

- ·Primex Technologies
- General Dynamics
- •Dayron
- Contraves Brashear



Objective Individual Combat Weapon



Next Generation Small Arms

| Advanced Medium Mission Specific | Machine Gun

Weapons

Objective Crew Served Weapon

Leap Ahead

Biography for Mr. Victor Galgano

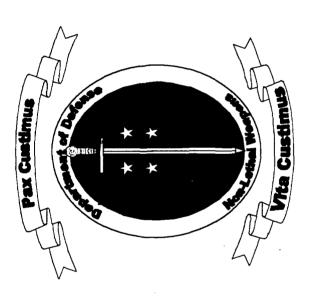
Mr. Galgano joined the Government in 1967. He spent his first 10 years in the Fuze Division in electronic fuzing and the last 21 years in the Fire Control and Software Engineering Division.

Mr. Galgano received BS in electrical engineering from Newark College of Engineering in 1967 and a Master of Science in Electrical Engineering from Newark College of Engineering in 1971.

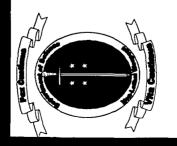
Mr. Galgano is currently the chief of the Indirect Fire Branch in the Fire Control and Software Engineering Division, FSAC, TACOM-ARDEC. In this capacity, he is responsible for Fire Control Systems for all indirect fire mortar and artillery weapon platforms.

Prior to his current assignment, Mr. Galgano served as the Chief of the Armored Vehicle Team from 1984-1994 and as the Development Project Officer for Mortar Fire Control Systems from 1994-1996.

Joint Non-Lethal Weapons Program The U.S. Department of Defense



A View to the Future June 1998



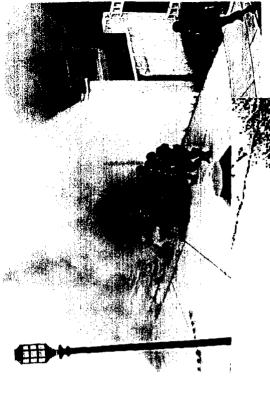
Purpose

Joint Non-Lethal Weapons Program and some thoughts on where the To provide an overview of the U.S. Department of Defense Program needs to grow

Emerging Operational Environment

Conflicts characterized by:

- Urbanized Terrain
- · Within the Littoral
- Non-state Actors
- "Subtle War"





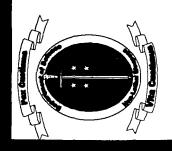
Military Commanders Challenges Facing



- Availability of Technology
- Public Misconception
- Increased Legal Issues

- · Noncombatants
- Media Factor





The Real World

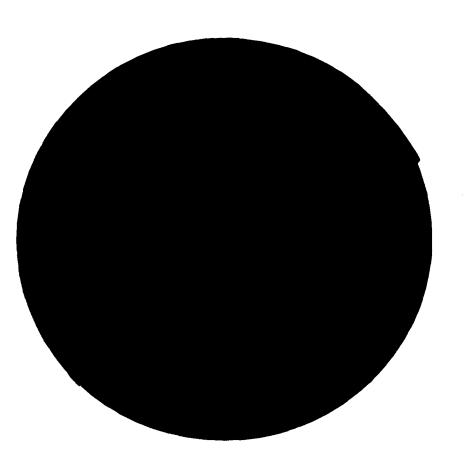
* Haiti/Bosnia

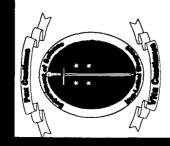
* Iraq

Sri Lanka?

Cuba?

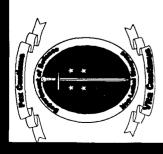
NEOs?





Defense Planning Guidance FY 2000 - 2005

levels must be integrated into all future military combat operations and the many categories of " NLWs have proven useful across the range use of NLWs from the strategic to the tactical Current efforts to study and understand the of operations, including both conventional and interagency concepts and operations. military operations other than war...



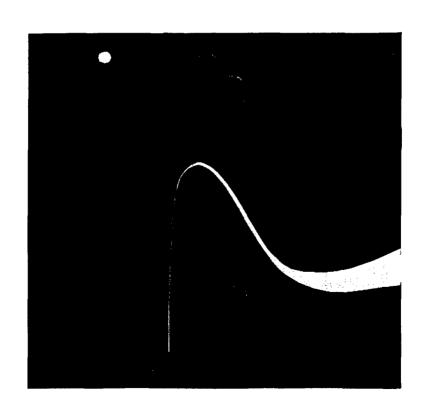
Where are NLWs headed?

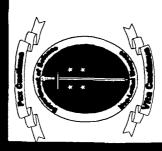




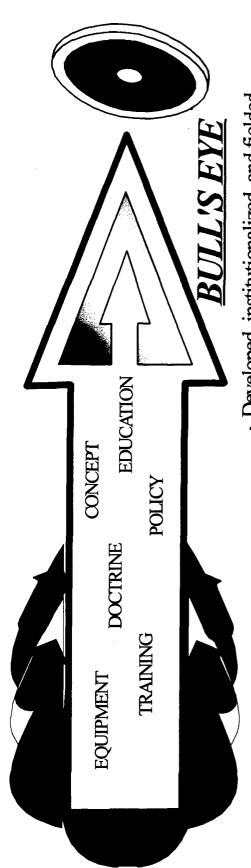
■ Blend of low tech, near-term with high tech, long range

Integrated capability across the spectrum of warfare

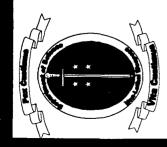




NLW Vision Arrow



- + Developed, institutionalized, and fielded integrated capabilities
- + Multi-spectral, multi-level battlespace relevance
- + Understood new military capabilities at all levels
 - + Integrated
- PolicyCINC OPlans
- Operations

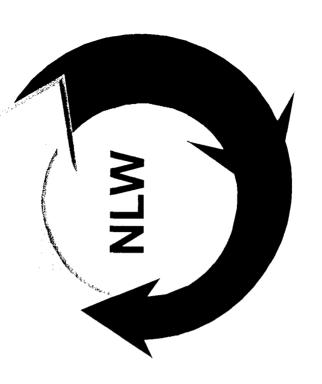


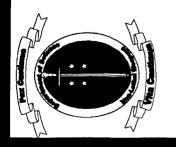
Current NLW Objectives

- Ongoing field support/ Capability Sets
 - Formalize training concept
- Meet or beat fielding timelines
- Realize a stand-off

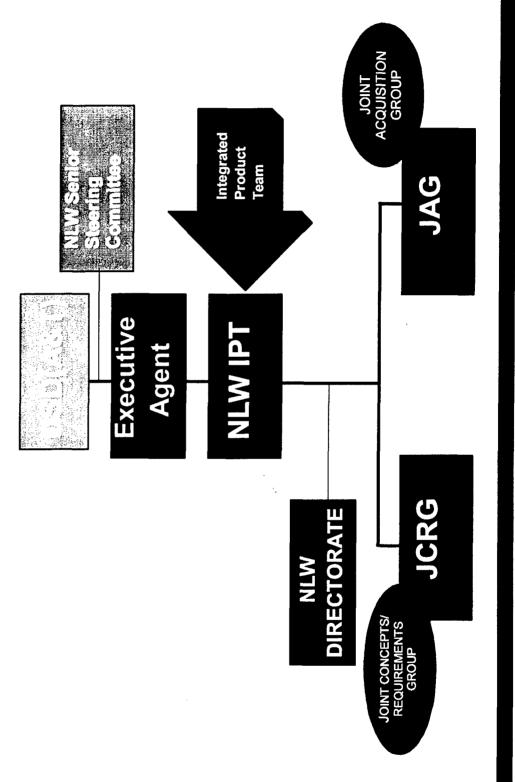
 NL strike capability

 NLW vision > 2025

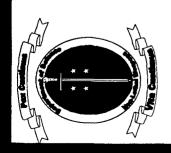




NLW Management Structure



338



The Joint NLW Concept Core Capabilities

Counter-Personnel

Crowd Control

Incapacitate Individuals

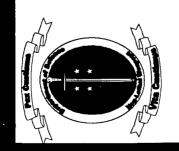
Deny Access

Clear Facilities/Structures

Counter-Materiel

Area Denial (land, sea and/or air space)

Disable/Neutralize Equipment or Facilities



The Joint NLW Concept Guiding Principles

Leverage High Technology

Enhance Operations

Augment Deadly (Lethal) Force

Provide Rheostatic Capability

Focus on Tactical Applications

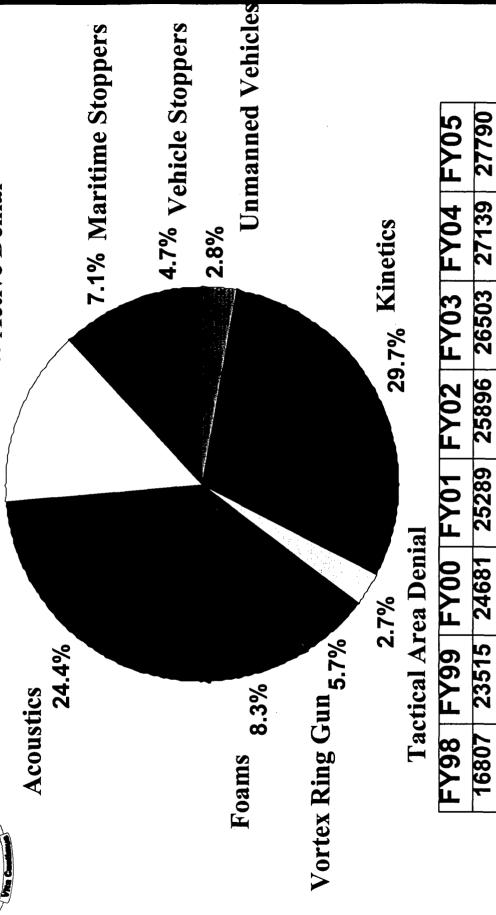
Expeditionary

Acceptable A

Reversible Effects

Technology Breakout

14.5% Active Denial



Note: In SK

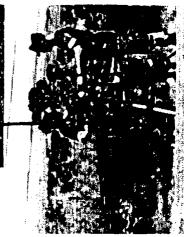
Current/Emerging Technologies



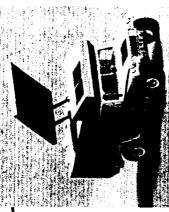
→ Kinetics/RCAs



→ Acoustics



→ Electromagnetics



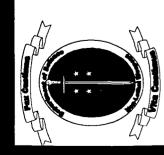
→ Lasers



なけか

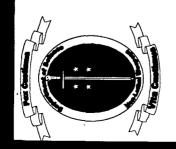
A Case For Non-lethals

- → Minimized casualties to noncombatants
- → Reduced post-conflict costs
- **→** Improved operational flexibility
- → Enhanced effectiveness of lethal force
- → Supports JV2010 Precision Engagement



A Case Against Non-lethals

- * More likely to employ military option
- * Increased complexity in operational decisions
- * Increased early media attention
- * Unrealistic public expectations
- * Encourages proliferation of NLWs



Evolving Concepts

> Layered Defense/Stand- Off

➤ Joint Operational Support
Stock (JOSS)
...

➤ Non-lethal Capabilities

Assistance Team (NCAT)

> Strategic targeting and delivery



Future Technology Concepts



Combustion Inhibitors

➢ Anti-microbials

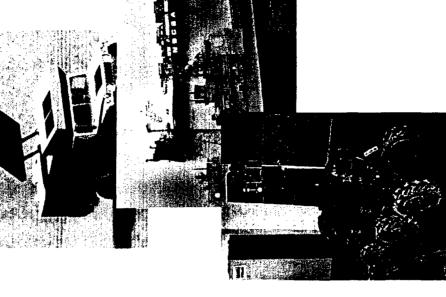
✓ Vortex Ring

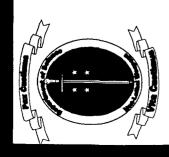
> Robotics

> Micro-miniaturization

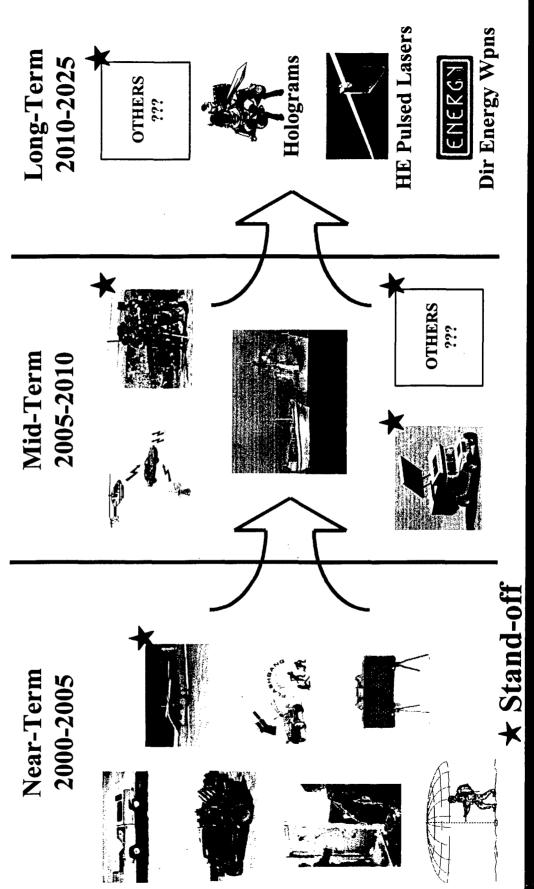
> NLW/10 Interface







Non-Lethal Technologies Into the Future

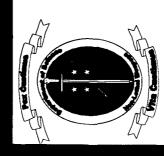


Joint Non-Lethal Weapons Directorate

347

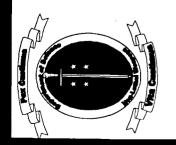
in Bosnia, Haiti and Somalia? What Have We Learned

- Low level of knowledge in theater
- ★ Highly charged, political environment
- Other NL options may be available
- Tactical employment concepts lacking
- ◆ Potential use against operational targets



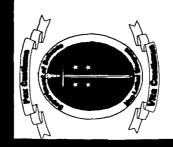
Rules of Engagement

- CINC Conference held 7-8 Jan 1998
- 🝁 Consensus achieved no separate Annex, or additional restrictions on commanders
- Emphasis needed on training and TTPs
- * Still looking to define "force"
- * Refine current ROE during upcoming review ongoing now



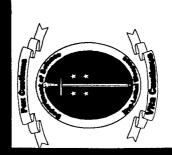
NLW Training Concept Joint Services

- Builds on past experience already exists
- Recognizes individual Services' training requirements
- Comprehensive NL training package for resident trainer and user course, and mobile training capability
- Training includes tactics, communications, crowd dynamics, weapons/munitions, and rules of engagement

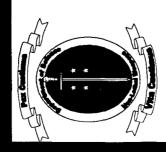


Other NLW Initiatives

- Joint NLW 2025 Vision
- · JNLW Web Site
- DOD NLW Database
- Joint Integration Project
- Annual Report
- Human Effects Panel
- · Foreign Exchange
- PAO Guidance



NLW Scenario Review



Somalia Redux

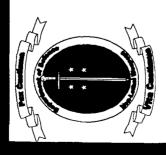
concerns. NGO support/security required. U.S. with numerous internal factions. Humanitarian Situation: Friendly government in disarray involvement solicited by all parties.

Conditions: - Violent mob behavior

- Infrastructure inoperative

U.S. Embassy centrally located

Requirement: Stabilize, secure feeding stations and infrastructure sites.



Southeast Asia Crisis

has attacked. U.S. citizens/interests at risk. UN Situation: Friendly government in disarray. Neighboring country with hegemonic goals action authorized to repel invasion.

Violent mob behavior Conditions: -

- MSRs clogged and impassable

Congested urban environment

Requirement: Massive evacuation of U.S. and allied noncombatants.

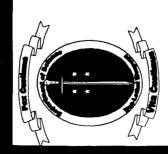
Son of DESERT STORM

U.S. interests and regional stability. UN-sanctioned attacks neighboring country. Invasion threatens deployment to stop invasion and restore border. Situation: Non-aligned, hostile government

Conventional, high intensity war Conditions: - Noncombatants shield key targets

- Maritime blockade effected

Requirement: Destroy enemy government ability to function while minimizing collateral damage.



Weapons of Mass Protection?

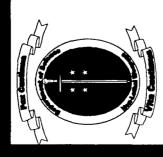
Situation: Biological weapons and manufacturing Potential for spread of terrorist activity is high. country. Host nation unable to address threat. facility uncovered in friendly but unstable

Facility located in dense urban area Conditions: -

Terrorist faction professionally adept

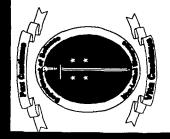
Restricted to covert special ops

Requirement: To isolate and destroy stockpile of biological facility with no collateral damage.



Operational Decision Complex

- Solution Is Interested a section of the section
- If not, will non-lethal force be appropriate?
- If so, which non-lethal technologies might apply?
- Where are they? How do I access them?
- What are the legal/ROE implications?
- What are my employment options?



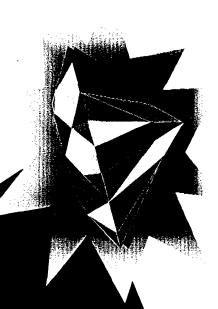
Summary

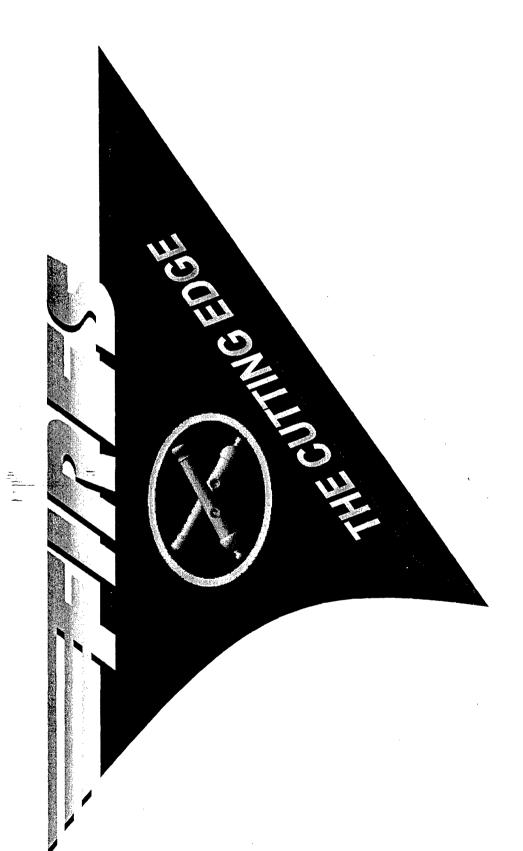
NLW Team

Focus on Soldier, Sailor, Marine, Airman

Form, Substance and Direction

The
Commander's
Non-lethal
Option

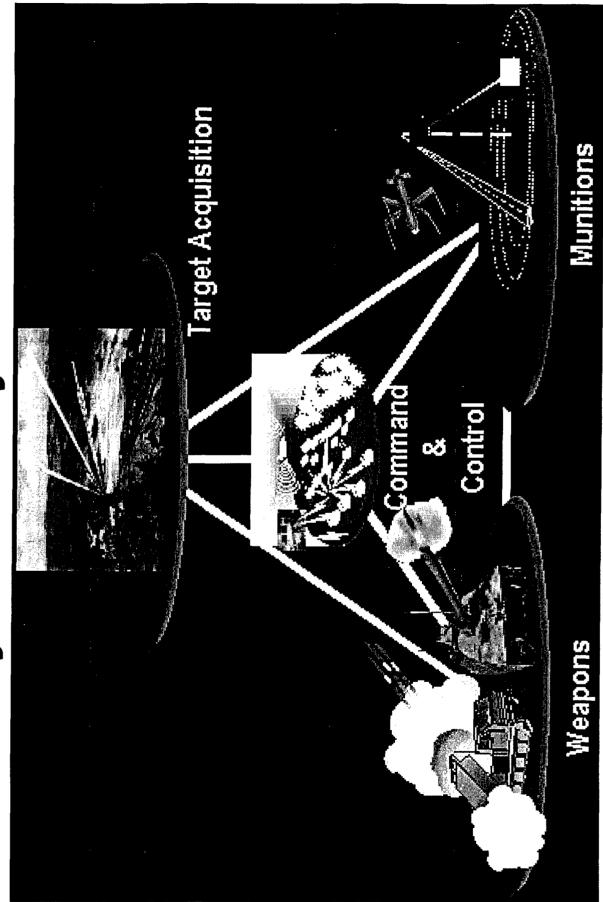




FA Materiel Requirements

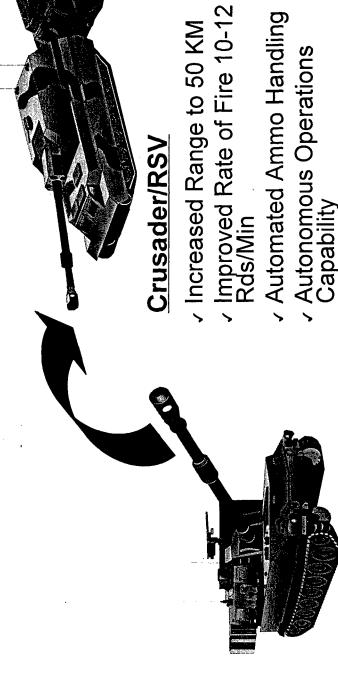
Mr. Ed Liles

System of Systems





Cannon Platforms



Paladin

Mobility Equal to Maneuver

Reduced Crew Size

Force

- Increased Range to 30 KM (Assisted)
- Incorporates GPS Pos Nav.
- Max Rate of Fire 4 Rds/Min (3 min)
- Automatic Self-Laying
 - Ballistic Computer Gun Drive Servos
- Digital Commo

- Wt. 5000lbs
- Inc. Lethality/Reliability
- Advanced Fire Control System

Complete Rounds in 12 Auto Transfer of 60 Minutes

- Auto Transfer of Fuel
 - 3 Man Crew
- Capacity of at Least 130
 RoundsFully Uploaded by Crew in 65 Minutes (Manually)



Greater Range

- Shoots on the move
- Advanced Propellant
- Composite Construction

...Ground Acquisition Program Auto transfer Auto transfer of Munition of fuel The Army's # 130 Rd Capacity Increased 50km Rg 10-12 Rds/Min rate of fire Improved **Autonomous** Capable of Ops

Cannon Artillery

Family of Munitions



SADARM

- 155mm, 2 Subs per Rnd
- √ ~ 20 Km Range (Paladin)
 - MMW & IR Sensors
- Formed Penetrator Warhead
- Small Footprint, Primarily Cntr-Btry

105mm Ext. Rg.

M119

(M915) (M916)

DPICM

Ext. Rg.

- 42 XM85 Subs
- Increased Range
- Increased Lethality
- Provide Lt Forces with DPICM

XM982: Ext. Rq.

- 155mm, Multiple Payloads
- ~ 50 Km RangeImproved DPICM & SADARM Subs
 - Bunker buster & minimize collateral damage



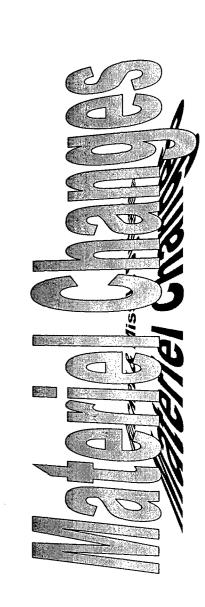
DPICM



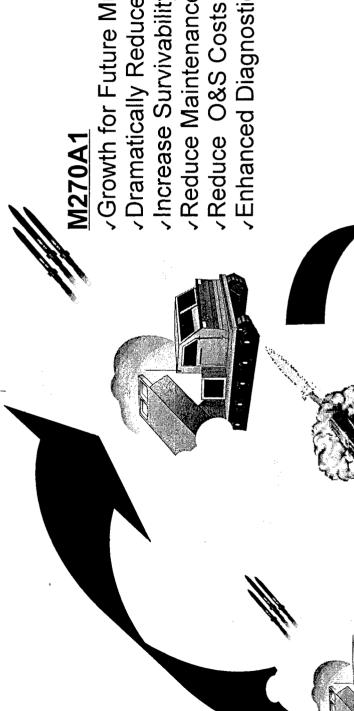
SADARM PI



UNITARY



Rocket/Missile Platforms



Growth for Future Munitions

Dramatically Reduce Timelines

Increase Survivability

Reduce Maintenance

Enhanced Diagnostics

Incorporates GPS In Pos Nav Unit

HIMARS

M270

Heavy Weight FS for Light & Incorporates Parts of ILMS/IFCS

Early Entry Forces

On-Board MET

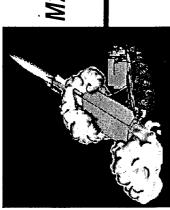
Operating Range 400(+) kmAutomated Robotic Loading

System

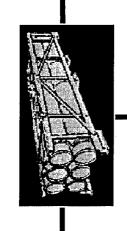
Composite Material

Rocket/Missile

Family of Munitions



M270 / M270AI



HIMARS







Extended Range Rocket

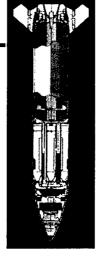


Guided MLRS

Rocket



MLRS Smart Tactical Rocket (MSTAR)



Smart ATACMS w/Bat

Basic ATACMS



Smart ATACMS w/Bat Ext. Rg.

Extended Rg. ATACMS



BAT

P31

Target Acquisition

Mortar, Arty,



Q36(V8) BIK II

- New Signal Processor
- Ltwt Multi-Purpose Shelter
- Data on Hard Drive & CD
- Enhanced Prob. of Location
- Remote Opns
- Electronics Upgrade

Q37 BIK I

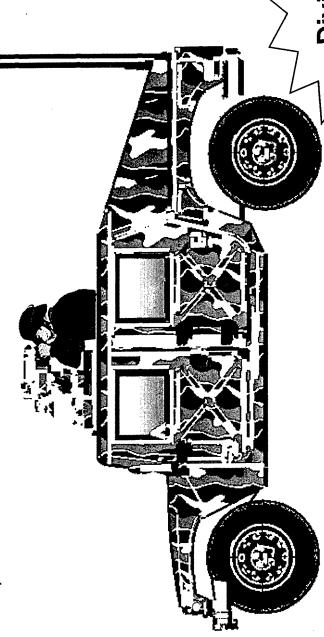
- ✓ Track Suspension System
 ✓ C-130 Transportable
- Incorporates Self-Survey
- Upgrades Cooling System Improves Maintainability
- Shelter on HMMWV



Q47

- Advanced Technology
- High Speed Processing
- 300 km
- Greater Survivability

Target Acquisition STRIKER



Division AWE Success

Organic to DS Bn

Direct Spt to Bde Recon Troop

Battlefield Combat Identification System

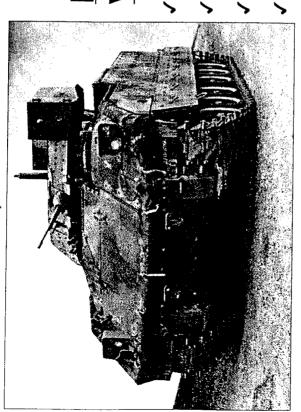
/ Fully Digitized

Reduced Signature

/ Improved Mobility/Survivability

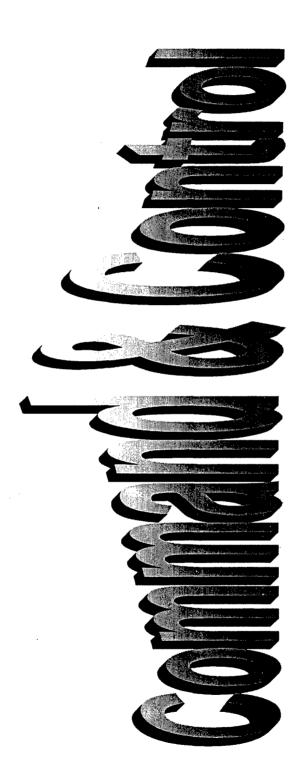
Approved for Rapid Acquisition

Target Acquisition



BRADLEY FIRE SUPPORT VEHICLE BFIST M7/M7A1)

- Ring Laser Gyro
- Improved Targeting Station
- Software: Under AFATDS Umbrella
 - Enhanced Mobility, Survivability & Maintainability
 - / Fully Digitized
- 2d Generation Forward Looking Infrared Radar (FLIR)
- Battlefield Combat Identification System
- Integrates Upgraded FIST Mission Equipment



Command and Control



AFATDS

- Major Component of Army Battle Command System
- Distributed/Decentralized Control
- Prioritized Target Attack
- V Fire Support, Not Just Field Artillery
- Unique Software ABCS
 Common Hardware
- Redefine Command Structure



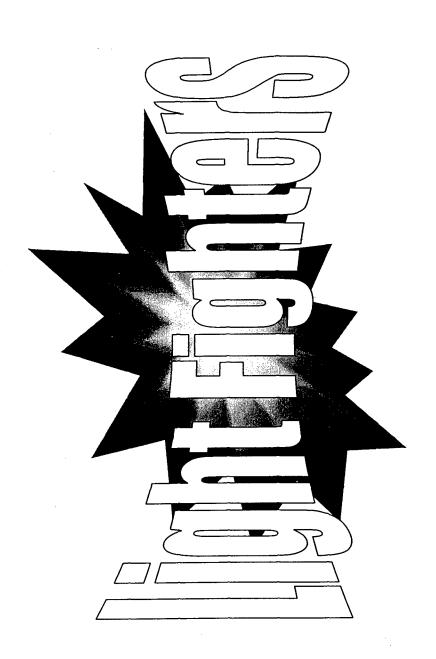
- Potentially redefine echelons of control
 - Redefine command structure
- A Potentially redefine current missions

 A Potentially redefine current missions

 Output

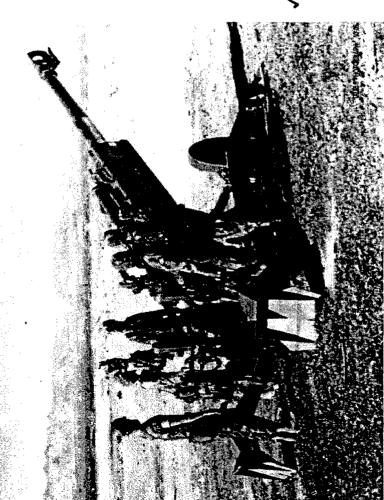
 Description

 D



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LIGHT WEIGHT 155



155MM TOWED HOWITZER

- USMC Mission Need
 Statement (1993)
 Endorsed by Army (1994)
 - Joint Venture to Evaluate Prototypes
- Joint ORD Approved by USMC (22 Jun 95) and DA (29 Sep 95)Weight 9000 lbs

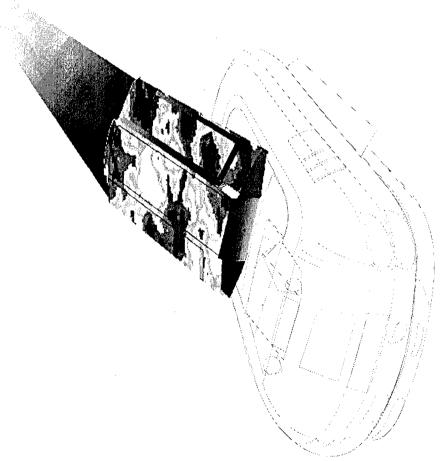
USMC/Army

Joint

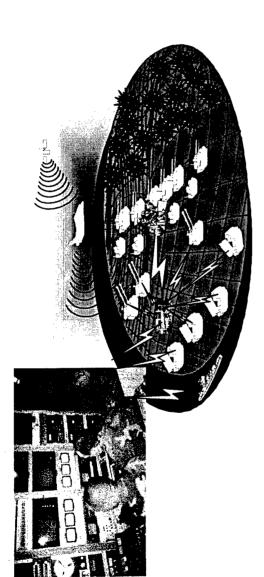
7

Effort





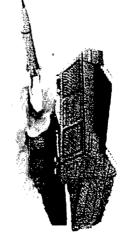
Effects Control Center...



- Operates at tactical and operational level
- Plans & coordinates employment of fires from space, air, sea & ground-based delivery systems
- Links best available sensors and fires platforms for precision engagement
- Allocates and deconflicts airspace
- Controls and synchronizes effects throughout the battlespace
- Performs continuous D3A

...unified view of the battlespace

Platforms of the Futures



- On-Board MET
- Operating Range 400(+) km
 - Automated Robotic Loading System
- Composite Material

Ädvanced Propellant

Construction

Composite

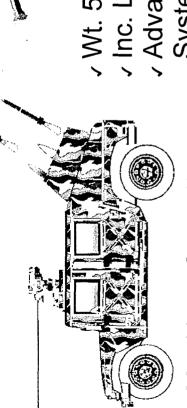
Shoots on the move

Greater Range



- / Wt. 5000lbs
- Inc. Lethality/ReliabilityAdvanced Fire Control
 - System

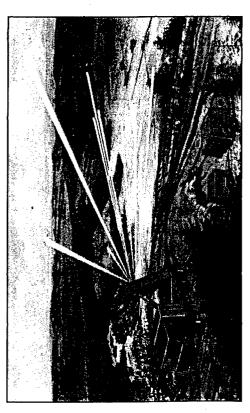




- Munitions Centrality Directed Energy
 - Multiple Chassis

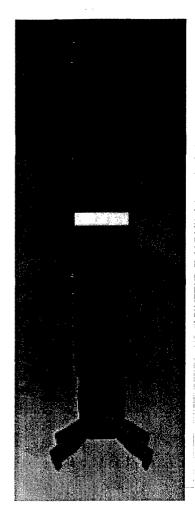


Target Acquisition



Q47

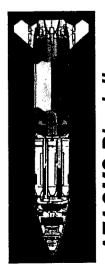
- Advanced Technology
- High Speed Processing
- 300 km
- Greater Survivability



Battlefield Damage Assessment

- Platform launched
- Jean description de la contra della contra de la contra de la contra de la contra de la contra della contra de la contra de la contra de la contra de la contra della cont
- Transmits to ground base receiver
 - Range capability 4-300km

Munitions



ATACMS Block II



ATACMS Block IIA



BAT



DPICM



UNITARY

155 Extended Range Projectile (XM982)

- 7 155mm, Multiple Payloads
- √∼ 50 Km Range
- Improved DPICM & SADARM Subs
- Additional Earth Penetrator Capability for Cannons

Objective: Munitions Centrality



PM SADARM Programs

June 23 1998

Presented By:

COL BERNARD ELLIS PROJECT MANAGER for SADARM (973) 724-2003

















Mission

Provides enhanced fire/counterfire support against stationary, armored vehicles well beyond the forward line of troops.

SADARM enables rapid engagement under inclement weather, and degraded battlefield conditions.

Performance Submunition weight (lbs)

155mm

22.5

Range (KM) (Paladin) Range (KM) (Crusader)

Special Features

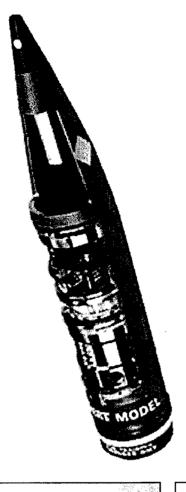
Submunition Diameter (in) Number of Submunitions

155mm

2/rd

Sensors

- Active and Passive Millimeter Wave
 - 1 Color Infrared
- Magnetometer as the "fourth" sensor



Key Contractors

- Prime Contractor
- Aerojet Electronic Systems, Azusa, CA (CPIF)
- Prime Subcontractor
- Alliant Techsystems, Inc., Minnetonka, MN

Fielding Data

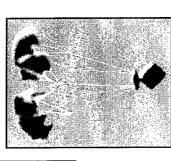
FUE 155mm: Jul 99

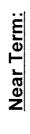










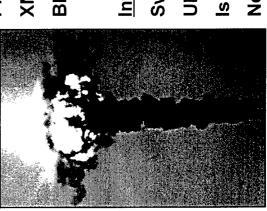


Jul/Aug 98 Dec 98 Jul 99 ASARC IOTE FUE



Far Term:

FY02 **Block II SADARM Army XXI** FY01 PI SADARM XM982

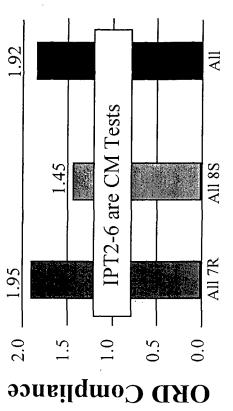


International:

Norway Greece France Korea **Netherlands** Swiss Israel



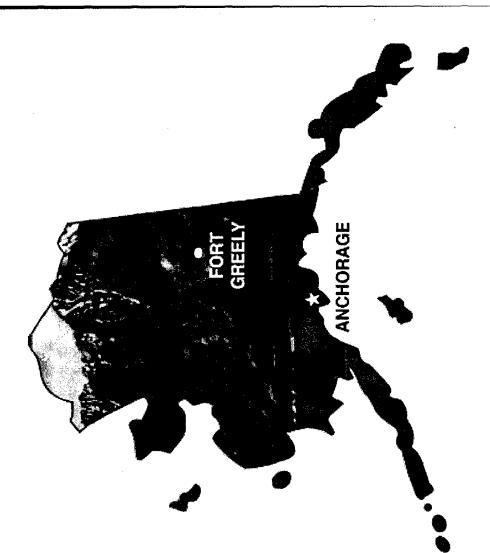




IPT 1 Thru 7

SADARM is only going to get better!

- Improving Reliability
- On Track for OT/ASARC/FUE
- ·Poised for PI Cut-In







Key Element	FY96 FY97	FY98	FY99 FY00	FY01	FY02	FY03	FY04	FY05
Milestones MS IIIA LRF	RP ▲	MS III	∆FUE					
PRODUCTION TESTING	4							
Live Fire Test		VV		••••				
IOTE		\triangleleft		• • • • • • • • • • • • • • • • • • • •			• • • • • • • • •	
PRODUCTION DELIVERIES	ග							
Low Rate								
Full Scale			• • • • • • • • • • • • • • • • • • • •					
PI SADARM-EMD				∇				





Mission

- Provides the maneuver force with improved fire reducing, accuracy enhancing, more lethal family support through an Extended Range, fratricide of 155mm projectiles in support of Force XXI operations.
- ⇒ DPICM with 64 Submunitions
- ⇒ SADARM with 2 PI-SADARM Submunitions
- Unitary with Bunker Penetrating HE Warhead

Capability/Improvements

- Increased Range:
- 28 to 37 Km + Paladin / M198 / JLW155:
- + Crusader:

40 to 47 Km

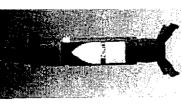
- Increases Survivability Through Greater
 - Stand-off Ranges

Key Contractors

- Raytheon TI Systems
- Primex Submunitions
- KDI FS&A
- ⊢ Rockwell Collins GPS Allied Signal - IML







Characteristics/Special Features

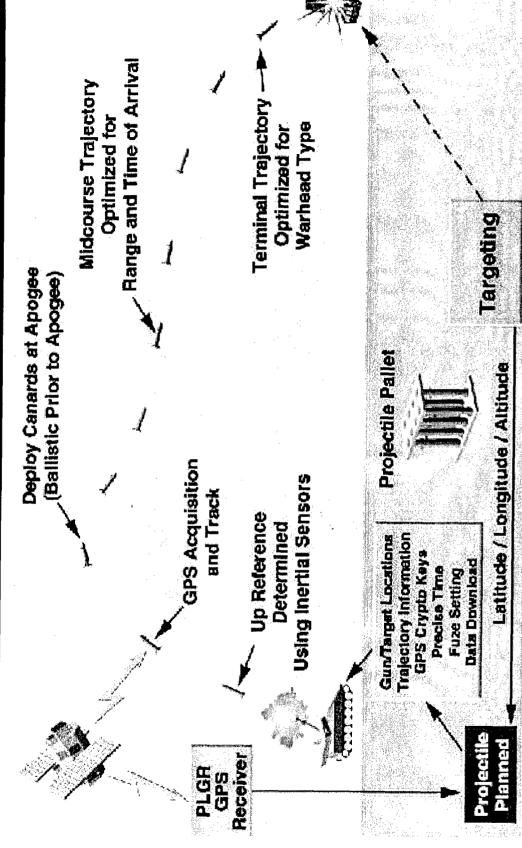
- One Meter Length / 106 lb
- **DPICM Submunitions with Self-Destruct Feature**
 - On-Board Self Locating System (SLS) - GPS / INS Guidance
- Inductive Set Integral Fuze PIAFS
 - Fin Stabilized Glide Air Frame
- Anti-Jam Features
- Modular Projectile Configuration

Initial Operational Capabilities

- DPICM
- SADARN
- 10 FY04 1Q.FY07

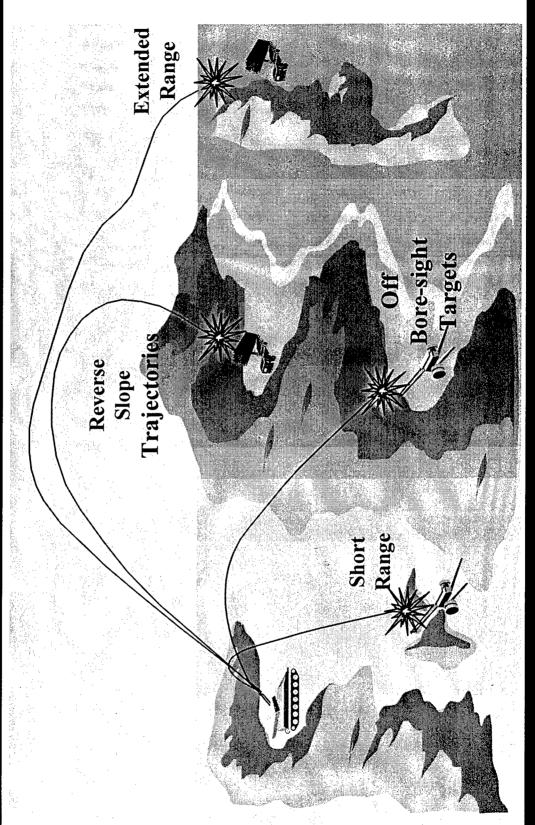














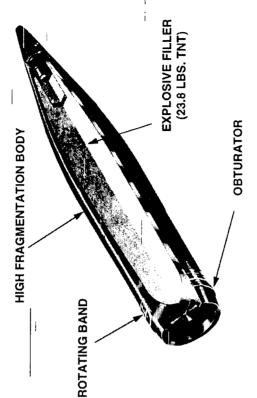
Mission

Interdiction (H&I), Fragmentation, Mining, and Provides Fire Support for Harassment and Blasting Effects.

Performance	M107	M795	% Inc
Weight (Lbs)	95	103	8%
Payload (Lbs)		23.8	59%
Range (Km) (Paladin) 17.5) 17.5	22.5	28%
Range (Km) (Crusader)18.5	er)18.5	31.0	68%

Special Features

- Precision (Avg Range Probable Error) 0.2-0.3 % Ballistic Similitude with M483A1 DPICM ·Effectiveness:
- Soft Material (Trucks): 1.2-1.8 Times Stnd M107
- Compatible with the 39 Caliber and Crusader Gun - Hard Material & Psnl: 1.5-2.0 Times Stnd M107 Tubes



-TOTAL WEIGHT = 103 LBS

Acquisition Strategy / Key Contractors

- ·Metal Parts:
- FY 95-96 Chamberlain Mfg following Restricted Competition between SCAAP/LAAAP
- FY 97-98 Restricted Competition U.S. & Canada Metal Parts:
- FY 95-96 Sole Source to lowa AAP
- FY 97-98 Restricted Competition U.S. & Canada

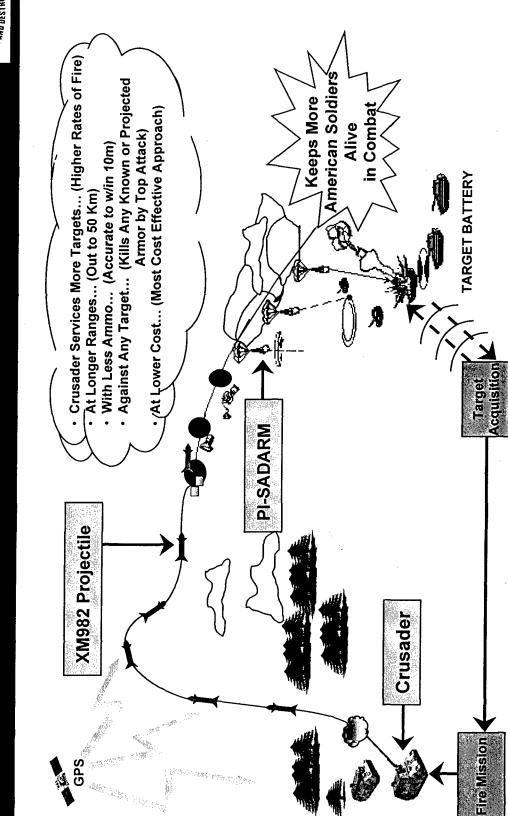


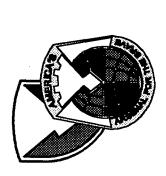


- Management for the Artillery Family of Munitions PMO SADARM charged with Life Cycle - All Calibers - All Components
- PMO SADARM
- ▲ Drafted Life Cycle Strategy for Artillery Munitions
- ▲ Life Cycle Data Base in Development
- Army is Trying to Figure out Munitions Life Cycle Management
- What's Next?
- Get Activity Based Cost Management System in Place to Identify Cost Drivers by Munition Family



PEO











M109A6 155mm Self Propelled Howitzer Digitization Initiative

National Defense Industrial Association Presented to: 23 June 1998

Presented by:

Mr. Chuck Jacob

OPM Paladin/FAASV

As of: 6/23/98

Tank-automotimente Armanants COMmand

768

Paladin Digitization Initiative

r alaum Digitiza Where Am 1?

Increase Survivability

Where Is the Enemy?

Provide
Situational Awareness

Increase OPTEMPO

Increase Lethality

Where Are My Buddies?

★ United Defense ★ PM Paladin/FAASV ★ Mitre (FFRDC) × ME Paladin Team ★ DCD at Ft Sill * DCSOPS ARDEC

Committed to Excellence

As of: 6/23/98

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Alternative Paths To Situational Awareness

Mortar Fire Control Paladin Howitzer Wolverine Crusader Abrams Bradley MLRS

★ Choice For 'Heavy Hitters' EBC

★ Avoids 'Swivel Chair' Operation

★ Minimizes 'Boxes'

Situational

Embedded Battle Command (EBC)

Integrate

Software On Host Platform

Awareness

Add

OR

Force Battle Command Brigade & Below FBCB2) Applique Computer

FAASV

Grizzly

Interim Solution For Some Weapon Systems Other Vehicles Without a Host Computer

Committed to Excellence

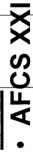
As of: 6/23/98

Paladin Digitization Strategy

1993

Automatic Fire Control System (AFCS) Field Original





1997

- Pentium Upgrade
- Windows NT OS

Replace Monochrome

Integrate EBC

2000

Current Focus

Graphical Display

Display with

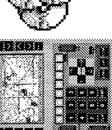
Factical Internet

BCIS

GPS Integration







To Follow

ADO-Approved

Migration Plan

Fraining & Diagnostics Improved Embedded

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Graphical Display Characteristics

Display Situational Awareness Maps Plus Battlespace Overlays

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Components

Enable Future Upgrades

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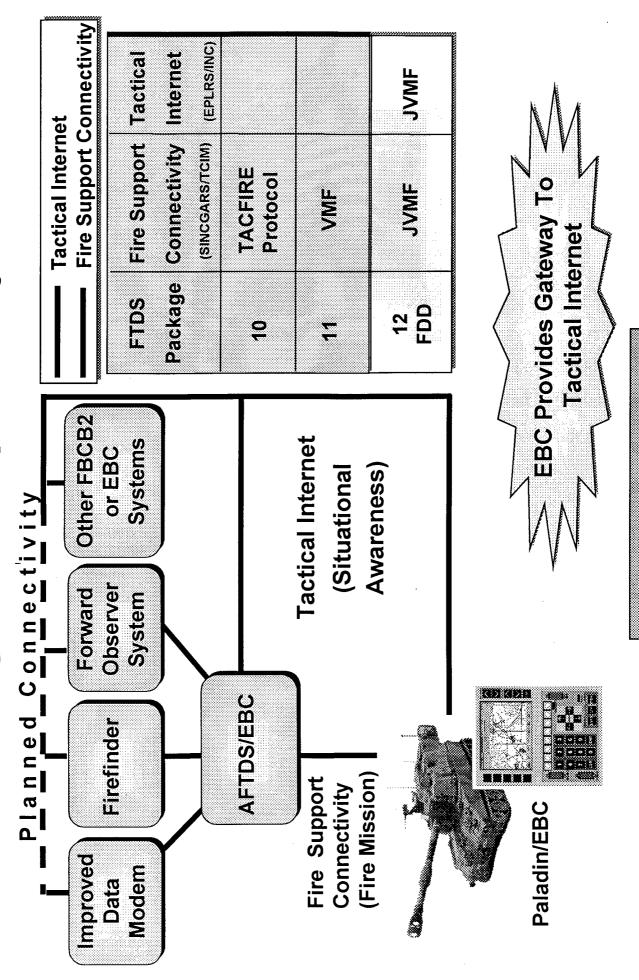
CLR

Retain Familiar Fire Mission Interface Toggles Readily Between Fire Mission and Situational Awareness 'Windows'

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Digital Interoperability

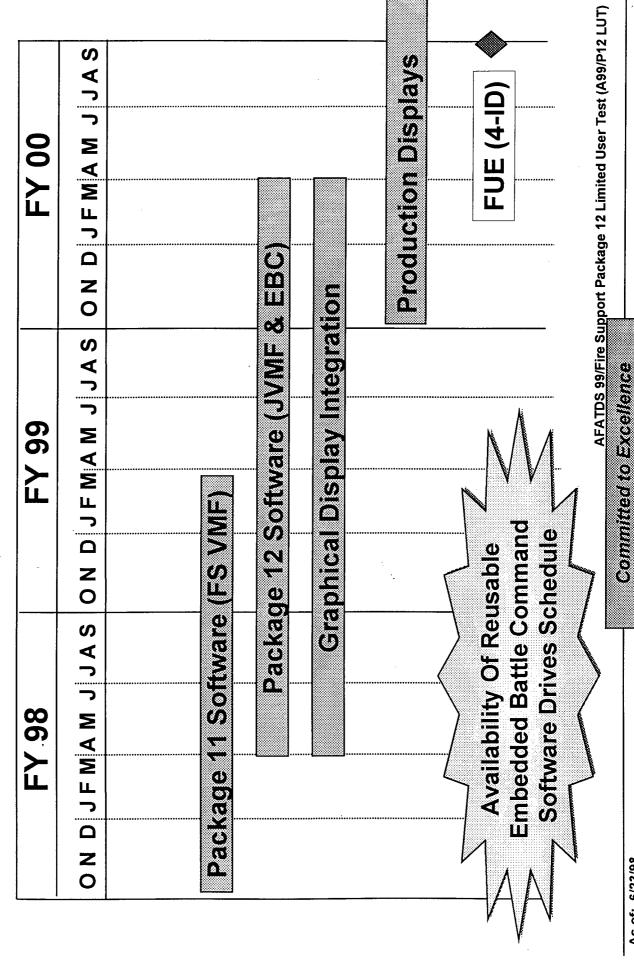


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Baseline Schedule - First Unit Equipped

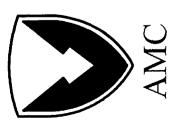


As of: 6/23/98

Summary

- Keep The Soldier Machine Interface Simple
- > Minimize Training
- > Maximize Fighting Effectiveness
- Keep It Simple for Maintenance Personnel
- > Reduce The Number of 'Boxes'
- > Improve Embedded Diagnostics
- Manage Life Cycle Costs
- > Performance Specification
- COTS Components and Commercial Operating System
 - > Plan for Upgrades
- Migrate to Real Time Common Operating Environment (RTCOE)
- Oriented Approach To Reusable Embedded Battle Command Software Successful Weapons System Digitization Relies On A Customer-
- > EBC Provider
- > Platform PMs

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Integration for Indirect Fire Horizontal Technology Weapon Platforms



Presented To:

Armaments for the Army of the Future NDIA Symposium and Exhibition June 22-24, 1998 Parsippany, NJ

Mr. Victor Galgano Chief, Indirect Fire Team Fire Control & Software Engineering Div. TACOM ARDEC Picatinny Arsenal, NJ 973 724-6021, DSN 880-6021 vgalgano@pica.army.mil

Mr. Xavier Minervini Manager, Business Development Navigation Systems AlliedSignal, Inc. 201 393-2791 xavier.minervini@alliedsignal.com

COH

Indirect Digital Fire Control Current Environment for

Only one fielded digital system - Paladin

Numerous fire control developments/planned improvements

MFCS in EMD

Crusader in DemVal

LW155 P31

M198

ATLAS

Paladin Upgrade?, Others?

Continued compatibility upgrades expected to SA and FS Nets Potential for proliferation of unique solutions

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The Premise

feasible, cost effective developmental Indirect Fire systems is a necessary, A common solution for fire control for approach The Mortar Fire Control System (MFCS) is an example of the common approach

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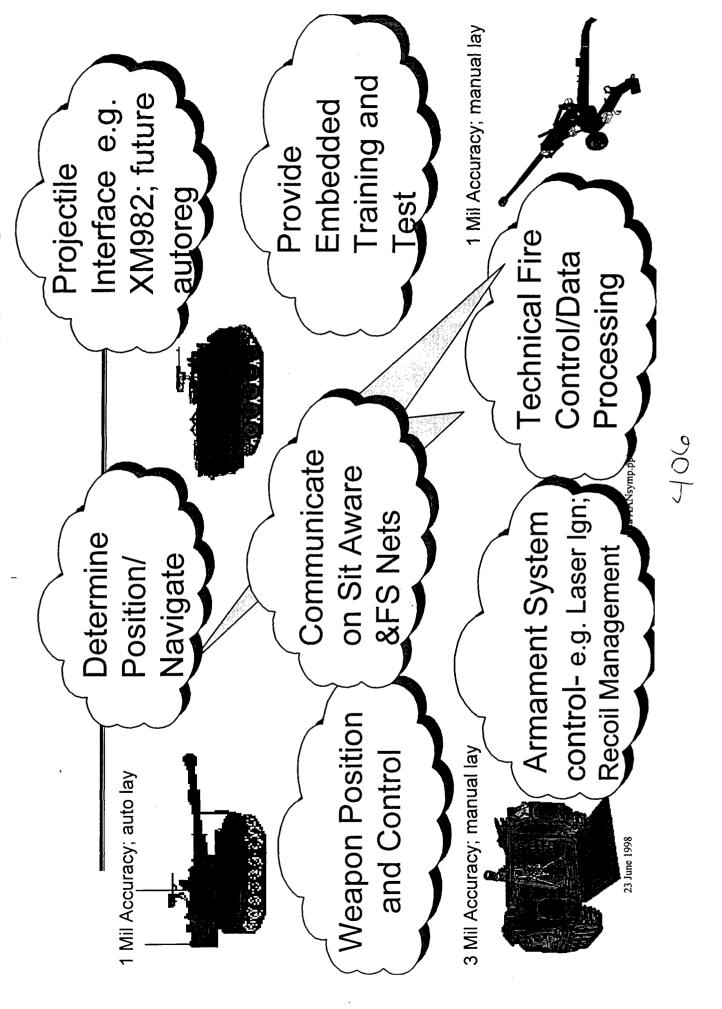
Why a Common Solution?

The fire control functions are the same their implementation varies

requirements are essentially the The "weapon -specific" technical same The "Weapon-Independent" mandated significant cost drivers and will requirements are the same, are continue

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The Fire Control Functions



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Weapon-Specific Technical Fire Control Requirements

	Paladin	MFCS	JLW155 3nd Gen	M198 (Notional)	ATLAS (Notional)	Next Gen Paladin
Position	10M	10M	10M	10M	10M	10M
Navigation	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Communication	SIP/TCIM	SIP/TCIM	SIP/TCIM/EPLRS	SIP/TCIM/EPLRS	SIP/TCIM/EPLRS	SIP/TCIM/EPLRS
- Fire Support	V10-13+	V11-13+	V13+	V13+	V13+	V13+
- Tactical Net	EBC	EBC	EBC	EBC	EBC	EBC
- Intersystem	VIS/1553/422/232	RF LAN/422/232	RF LAN/422	RF LAN/422	RF LAN/422	RF LAN/422
Pointing Accuracy	IM	3M	IM	IM	IM	MI
SMI	Text/GUI	GUI/Text Smart!	GUI/Text Smart?	GUI/ Text Smart?	GUI/Text Smart?	GUI/Text Smart!

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Weapon-Specific Technical Fire Control Requirements (Cont'd)

	Paladin	MFCS	JLW155 P3I	M198 (Notional)	ATLAS (Notional)	Next Gen Paladin
Power	Mil-S-1275	Mil-S-1275/ 12 hr Battery	State-of-the-Art	State-of-the-Art	State-of-the-Art	State-of-the-Art
Platform Intgrn	~10 Cables	Wireless LAN	Wireless LAN?	Wireless LAN?	Wireless LAN?	Wireless LAN?
Weapon Drive	Yes	No	Yes?	Yes?	Yes?	Yes
DFSS	Pantel	No	Yes	Yes	Yes	Yes?
MVS	Yes	No	Yes	Yes	Yes	Yes
Embedded Trng	Yes	Yes	Yes	Yes	Yes	Yes
Muzzle RS	No	N _o	Yes?	Yes?	Yes?	Yes?
BIT	Yes	Yes	Yes	Yes	Yes	Yes
Fuze Setter Intgrn (PIAFS)	Planned	Planned	Required	Required	Required	Required
			:			

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"Weapon-Independent" Mandated Requirements



Joint Technical Army Architecture (JTA-A)

Operating system

- Program language

- Soldier Machine Interface (SMI)

Situational Awareness

- SA Software: FBCB2/EBC

Radios: SINCGARS SIP/INC/EPLRS/Future Data Radios

FS Net

Message Formats: FSK, VMF, JVMF

Protocols: 188-220

SW Reuse

Ballistic Kernel

Comm Server

etc...

Battlefield Combat ID System (BCIS) - IFF

The Evolution of Paladin

- First digitized ground combat vehicle
- Only digitized indirect fire platform
- Product improved with MVS, DRU-H

A3s→HELP→HIP→Paladin

- AFCS XXI, Pack 10 FY97
- Pack 11 in FY 99 (Ballistic Kernel, VMF BOM)
- Pack 12 in FY 00 FDD (EBC)
- Pack 13 (MOFA, MACS, XM982)
- New display required for situational awareness
- PM considering upgrade Fire Control in 01/02 timeframe
- Continued compatibility upgrades expected



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What's best for the Indirect Fire **Community?**

A structured approach for coordinated definition and development of fire control for indirect fire weapon systems State-of-the-art hardware, best value IAW performance spec, warranty, CLS and maximum commonality with existing systems

Flexible Architecture - ability to isolate SW from HW: SW reuse/rehosting Ability to procure competitively and economically via common performance specifications at the subsystem level Horizontal Technology Integration of complementary hardware and software elements

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Advantages

Maximum use of existing, proven HW & SW Applicable to all indirect fire (and other) systems

Growth Oriented, concurrent deployment of Reduces EMD, Prod, Training, O&S Costs Enables modernization through spares Promotes HW commonality technology & capabilities

Same solution for M198, LW155, Atlas, next version Paladin

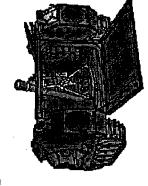
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Mortar Fire Control System

Five platforms addressed concurrently



Tracked 120mm

M577 Fire Direction



Towed 120mm



81 mm mortar



HMMWV Fire Direction Center

Single performance specification

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Mortar Fire Control System (MFCS)

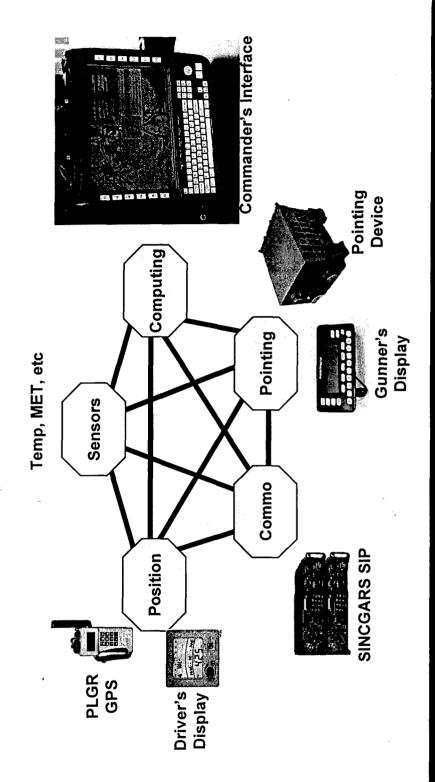
- Provides complete, fully integrated digital onthe-weapon fire control system for mortars:
- Weapon location and orientation
- Navigation
- Ballistic solution

Plus:

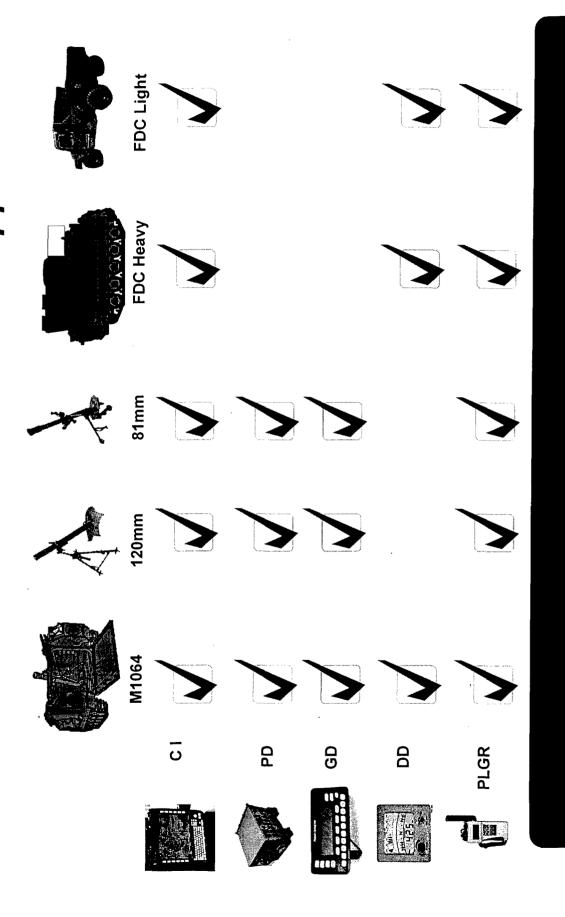
- Full FDC Functionality.
- VMF/BOM, 188-220 compatible.
- Compatible with all Package 11 FA systems.
- Army Technical Architecture compliant.



MFCS Architecture - Function/Hardware



MFCS Modular Cross-Platform Application



<u>-</u>

MFCS Weapon Lay

MFCS On-Board Survey System:

- Eliminates Need for Aiming Posts and Distant Aiming Points.
- Permits On-the-Move Computation of Targeting Solutions.
- Facilitates Paladin-like Shoot-and-Scoot Capability.
- Provides Real-Time Position Data for Situation Awareness.

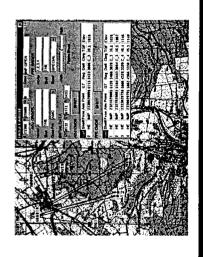
MFCS On-Board Pointing System and Displays:

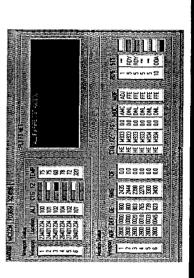
- Provide Real-Time Orientation Data to Gunner.
- Presents Gun Orders to both Gunner and Commander.
- Presents Weapon Lay data to driver.

MFCS Safety

MFCS On-Board Safety Measures:

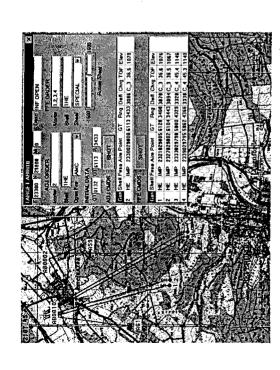
- Safety Fans
- Battlefield Geometry
- Embedded Battle Command / Common Picture
- Effectiveness Checks for all 120mm and 81mm Ammunition
- Warns of endangered Friendly
- Alerts of possible danger close situation





MFCS Tactical Fire Direction

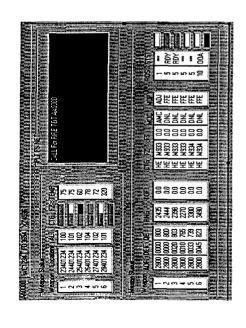
•MFCS Tactical Data Management:



- Graphical User Interface
- Platoon Level Data Management
- Weapons Control
- Simultaneous Independent Missions
- Coordination of Fires
- Coordination of Re-supply
- Selectable User Preferences / Defaults
- Integrated Situation Awareness

MFCS Technical Fire Direction

•MFCS Technical Fire Control:



- Graphical User Interface
- Ballistic Computation
- Generation of Gun Orders
- Weapons Inventory Status and Control
- Automatic Decrement of InventoryCompensation for MET
- Compensation for Propellant Temp.



MFCS Embedded Training

MFCS On-Board Embedded Training Aids

- Mission Simulations
- Monitor/Record User Interaction

Embedded Training Mode for Tactical Operations

- Platoon Level Training
- Unit Level Training
- Simulation of Inbound Tactical Messages and Commands
- Simulated Fires
- Data-Logging

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MFCS Attributes

Summary

Increased Survivability.

- Shoot & Scoot Semi-auto ops

- No dismount

Enhanced Lethality:

- First round FFE
- New weight class

Faster Response Times:

- Digital commo
- On board ballistics

Situational Awareness: - Current friend or foe situation

Increased Mobility:

- Decreased emplace times On board POS/NAV
- System Fielding
 FY2000

 Hardware/Software · Modular Architecture

- AFATDS Key Asset
 - ATA-Compliant
- · VMF/BOM, 188-220
- · FA Package 11Compliance

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Conclusion

Now is the opportune time to address The approach is feasible commonality Reduces cost, risk, development time

Same solution for M198, LW155, Atlas, next version Paladin; technology interchange with Crusader A coordinated approach is the only affordable solution

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EMERGING TECHNOLOGIES FOR LIGHTWEIGHT ARTILLERY SYSTEMS



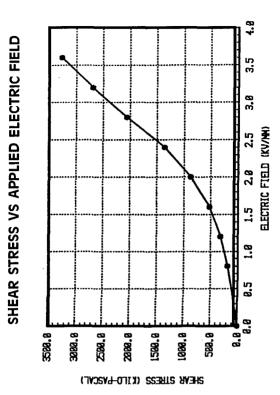
- Electro-rheological (ER) fluids to enhance recoil control
- Isogrid structures to reduce weight while maintaining strength
- Technologies can be applied to any artillery system

**** GENERAL ATOMICS**

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ER FLUID PROPERTIES

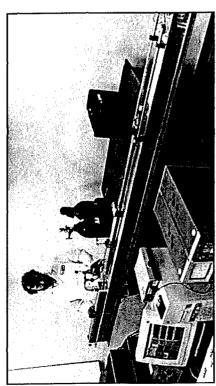
- ER fluids are dispersions of solid particulates in an insulating oil
- Fluid viscosity changes when electric field applied
- Functions as an electronic brake
- Controls motion and forces
- Fast response time(1 to 2 msec)
- control
- Fully reversible



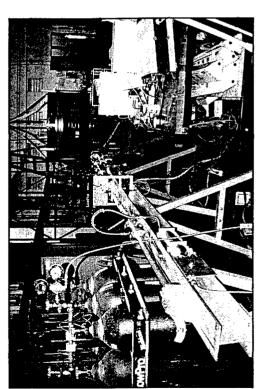


SUBSCALE HARDWARE SYSTEMS ER FLUID RECOIL CONTROL

Conventional recoil test hardware

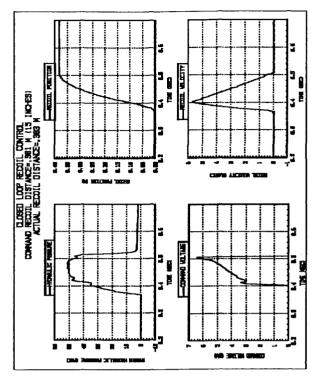


Soft recoil test hardware



Results

- ER Fluid control demonstrated (Full scale stroke, velocity and timing)
- Control instrumentation, data acquisition and software validated
- Established scale factors for full scale design and simulation



CENERAL ATOMICS

M-017(4) 6-3-98 927

ER FLUID TECHNOLOGY DEVELOPMENT AT GENERAL ATOMICS

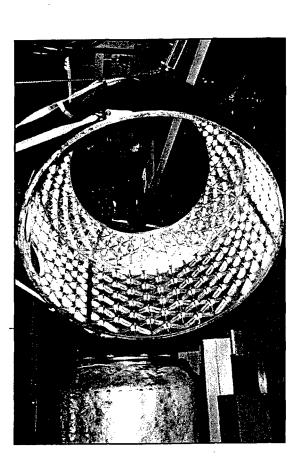
Have applied ER fluid technology to practical applications since 1987

ER Device	Application	Agency
Recoil Arrestor	Artillery System	Armament Research Development And Engineering Center
Clutch	Underwater Vehicle Propulsion System	Naval Underwater Warfare Center
Suspension System	Magnetically Levitated Train	Federal Railroad Administration
Acoustic Damper	Underwater Vehicle Noise Suppression	Naval Surface Warfare Center
Elastomer Vibration Damper	Underwater Vehicle Rotating Machinery Mounts	Office of Naval Research



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WHAT IS ISOGRID?



"iso" means Isoceles triangle! Isogrid is:

- An all metal ultralightweight structural technology
- Stronger than equivalent high strength/low weight plate structures of the same weight
- Infinitely variable in local strength; strength always matched to loads
- Structures analyzed using codes inherited from longterm aerospace projects

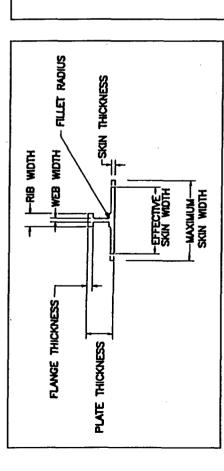


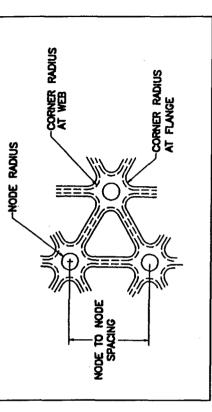
TIMELY AND APPROPRIATE? WHY IS ISOGRID

- 30 yrs aerospace experience/analysis for low cost
- machine tools are now almost universal Computer numerically controlled (CNC)
- All-metal construction beats honeycomb or composites for rugged Howitzer service
- Labor cost in production is minimized (less welding and machining of weldments)



WHY IS ISOGRID EFFICIENT?





"EFFICIENCY" MEANS HIGH PERFORMANCE WITH LOW WEIGHT

- Isogrid plates are thick but light
- Bending strength increases greatly with plate thickness
- The thin skin contributes because it doesn't buckle under loads - the ribs prevent skin buckling
- "SST" computer analysis allows every feature of the grid geometry to be optimized - no wasted metal



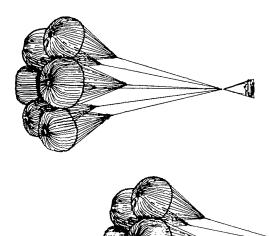
Advanced Technology Lightweight Artillery System (Atlas)

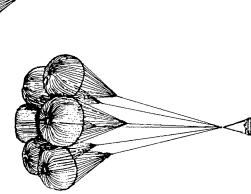












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M119A1 Emplacement



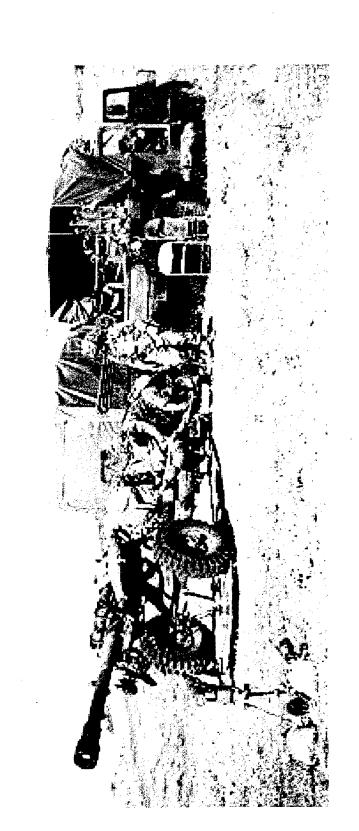


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M119A1 Emplacement





01/09/98





Key Requirements



- Strategically deployable using C-130
- Tactically mobile using UH-60L
- Rate of Fire:
- 5 RPM Max
- 2 RPM Sustained
- Direct fire capable
- 6400 mil shift by 4 crewmen
- Leverage emerging munitions



01/09/98



UH-60 FUTURE CAPABILITIES



FACOM-ARDEC

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RANGE(Radius) HOGE WT

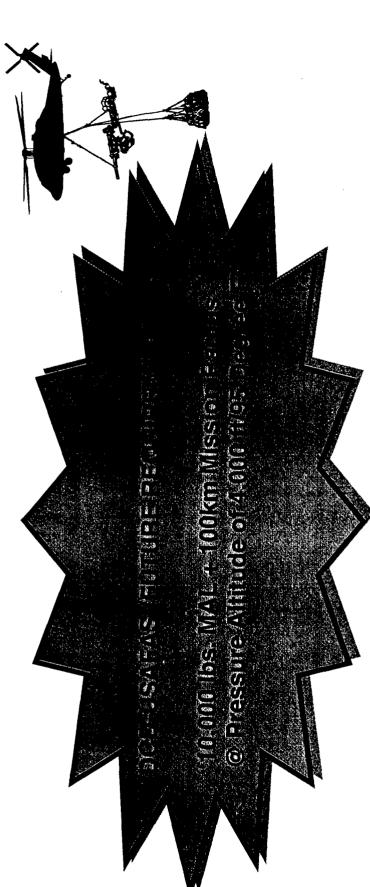
Max Allow. Load

UH-60L1 (**Set 1A**) UH-60L1 (**Set 2A**)

66km 66km

23,600 24,500

9,840 9,020

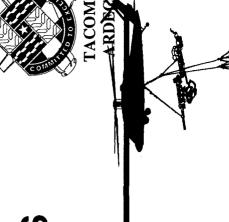


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AMMUNITION LOGISTICS





CONSIDERATIONS



ion Howitzer
Ammunit Tvoe

4200 lbs (M119A1)

05mm 55mm

5000 lbs (FDSWS) 5000 lbs (FDSWS)

55mm (HICAP)

1575 (@ 30 rds) 1632 (@ 12 rds) 1620 (@ 15 rds)

2002 lbs 2002 lbs 2002 lbs

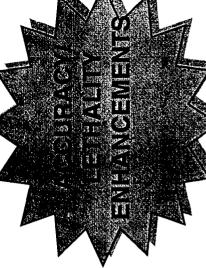
7777 lbs 8634 lbs

Weight

man)

Total

8622 lbs





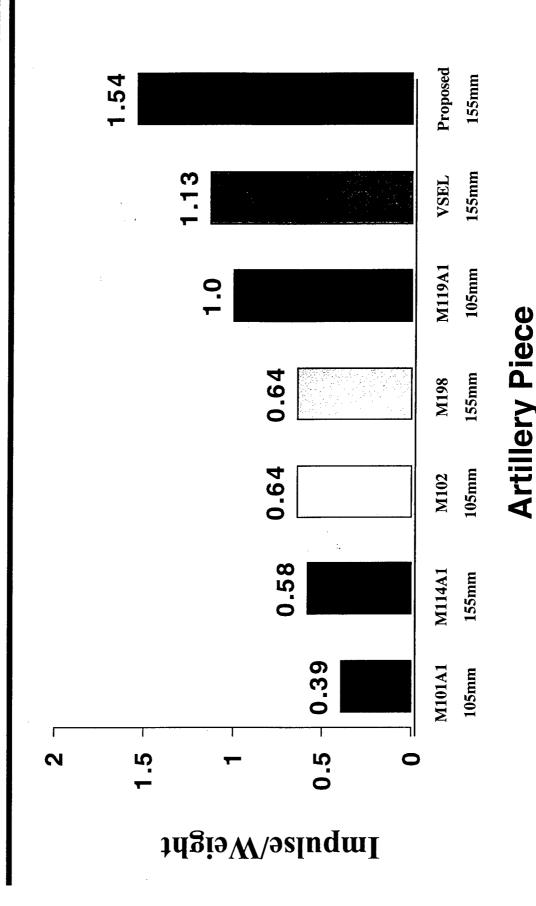


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Impulse To Weight Comparison Towed Artillery Systems





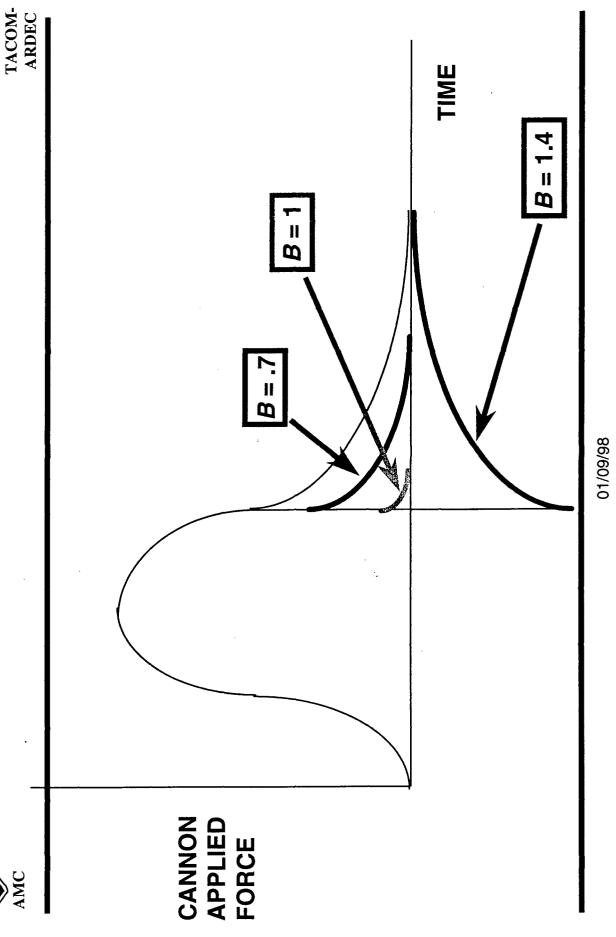
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Muzzle Brake Effects





Towed Weapon Impact



The next generation howitzers require unique recoil management techniques for stable, lighter weight systems with increased performance Key to lighter weight structure will be new materials and new manufacturing techniques

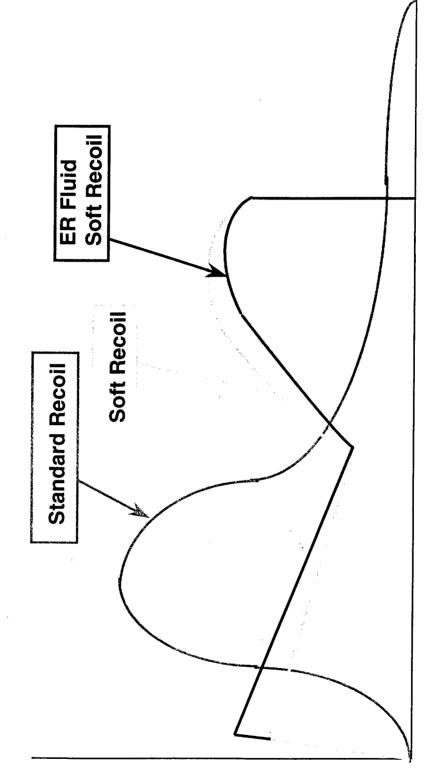
A 5000 pound 155mm towed howitzer is technically feasible

01/09/98



Effects On Weapon Force Transmittal





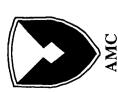
TRUNNION FORCE

TIME

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Managing Recoil Energy (Soft Recoil Option)



A method of managing recoil forces in a "failsafe" manner.

RECOIL MANAGEMENT

- CONVENTIONAL RECOIL CYCLE INBATTERY POSITION PULL LANYARD (0.0) FIRE
 - COUNTER RECOIL. RETURN TO BATTER (2.3) RECOIL-82000 lbs
 - SOFT RECOIL CYCLE
- (0.0) RELEASE FROM
 - RUN-UP.
 - RECOIL: 58000 lbs (0.2)
- COUNTER RECOU. (0.8) A

BENEFITS

- Reduced recoil forces
- Fewer parts
- Improved stability
- Improved reliability & durability
- Use low cost materials
 - Field repairable
- Reduce fluid heating

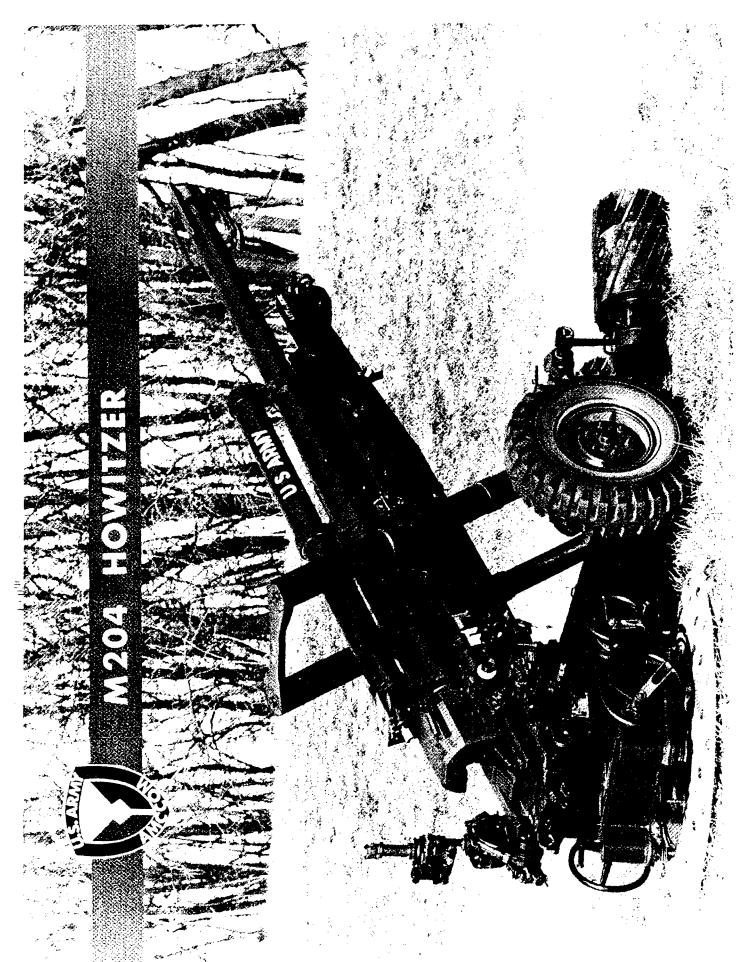


AVAILABLE TECHNOLOGY

• ER fluids

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TEST BED PROGRAM OVERVIEW



ARDEC

"ROADMAP"

'ACOM.

7000 lbs.

Testbed I (FY98)

- Soft Recoil
- Digital Fire Control
 - •MACS

5700 lbs.

Testbed II/ATD (FY00)

- Soft Recoil Control (ER Fluids)
- Lightweight Materials/ Advanced Structures
 - Laser Ignition

5000 lbs.

Testbed III (FY02)

Refinement of Key Optimization & **Technologies**

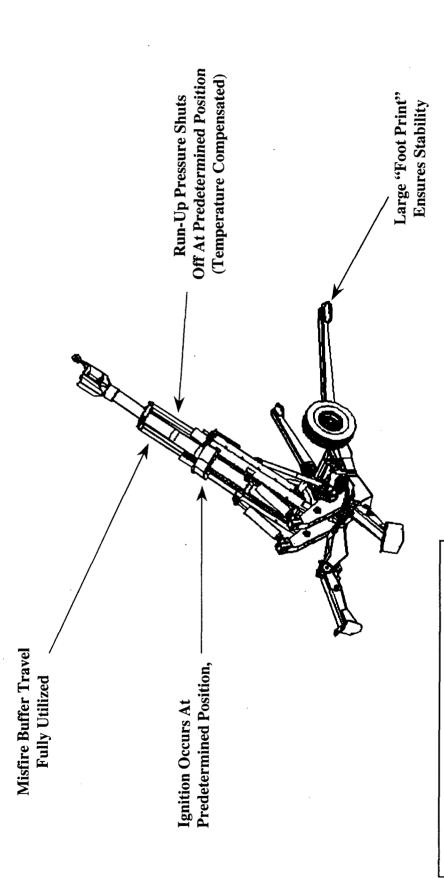
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Advanced Technology Lightweight Artillery System "Hybrid" Soft Recoil Design





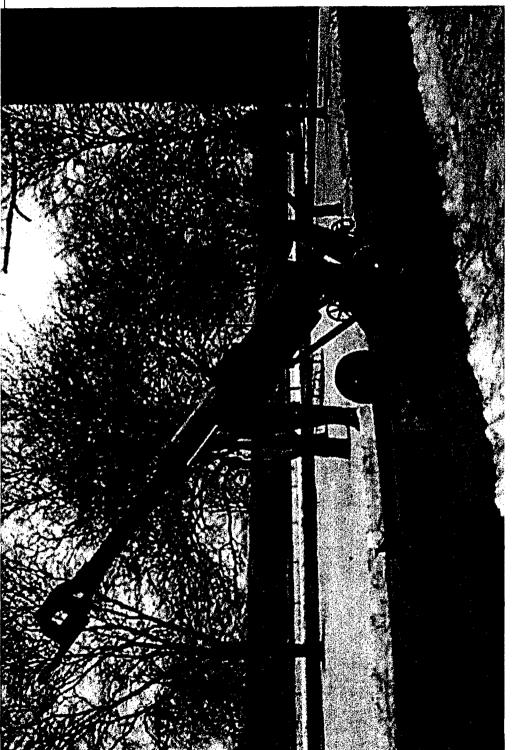
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Extensive Use Of CAD Modeling Will ensure Stability Under All Conditions

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ATLAS Test Bed 1





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Testing Plan Overview



Event	Task	Intermediate OBJ
Shakedown	Fire 24 rds start at 1 MACS and increase to 4 MACS	Structural Integrity Debug Data Acq Sys
Precision	140 rds, 70 from Center traverse 70 Rt traverse increasing chg & El	Cannon Data, mymt stability, recoil sys, dispersion, load paths
Direct Fire	Two 14 rd occasions 1000/2000 meters (0 mils)	Sight Alignment
Min/Max Rg	Two 7 rd occasions	Min/Max ranges

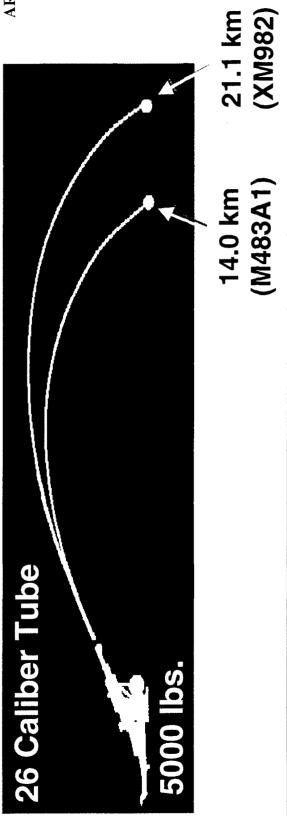


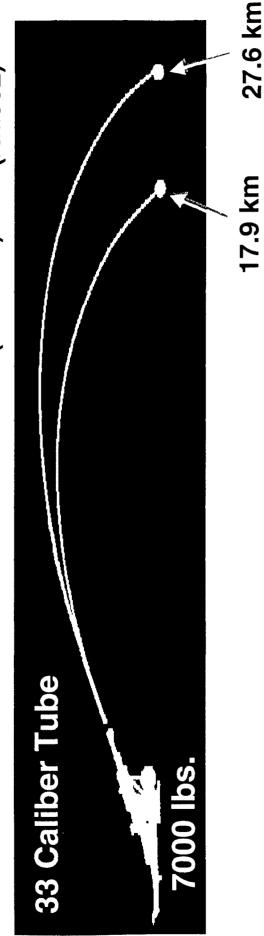


AMC

TB1 Range Estimates







M483A1)

27.6 km (XM982)

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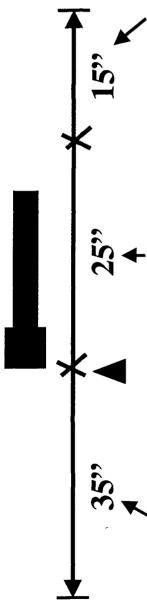
AMC

Recoil Management Technology



ARDEC CACOM

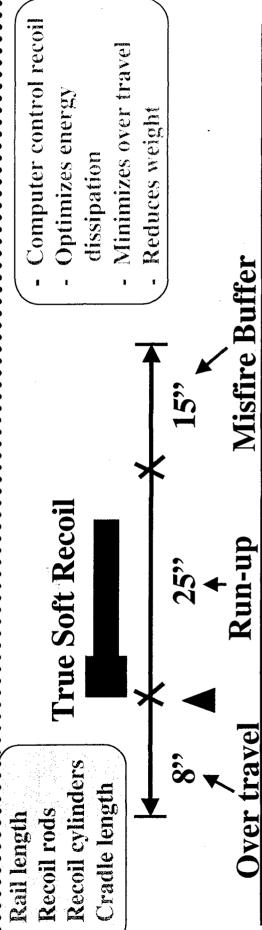
Hybrid Soft Recoil (Conventional & Soft)



Misfire Buffer

Over travel

- No computer control
- required for high zones Long over travel Adds weight



01/09/98

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"ACTIVE" RECOIL CONTROL WHAT IS IT?



- A fundamentally different recoil control methodology
- A closed loop feedback controlled fluid throttling process
- Active recoil control can provide a high degree of "finesse" in controlling the recoil event

RECOIL FORCE CAN BE "TAILORED" TO ENSURE STABILITY OF A LIGHTWEIGHT WEAPON

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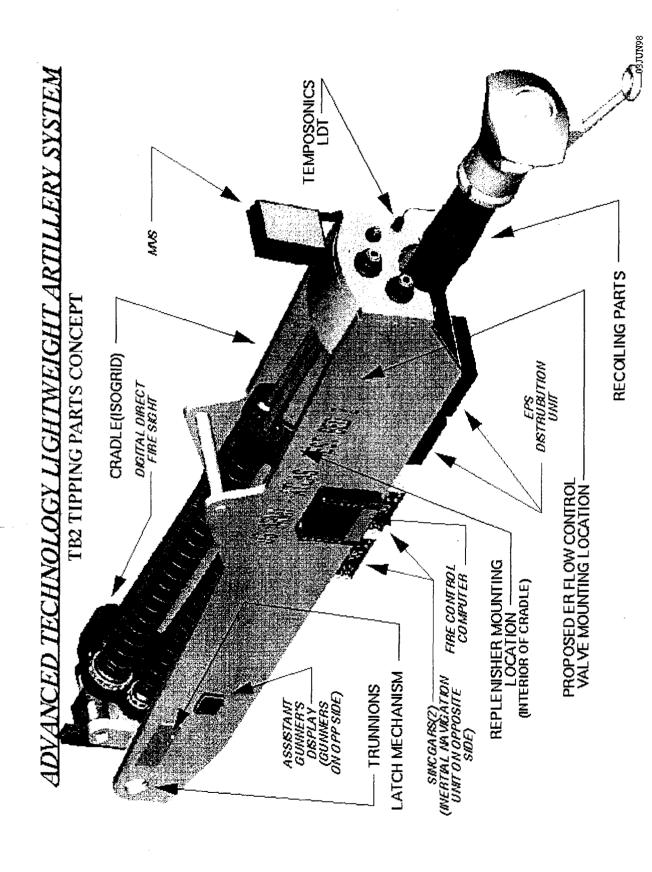


ELECTRO-RHEOLOGICAL (ER) FLUIDS WHAT ARE THEY?

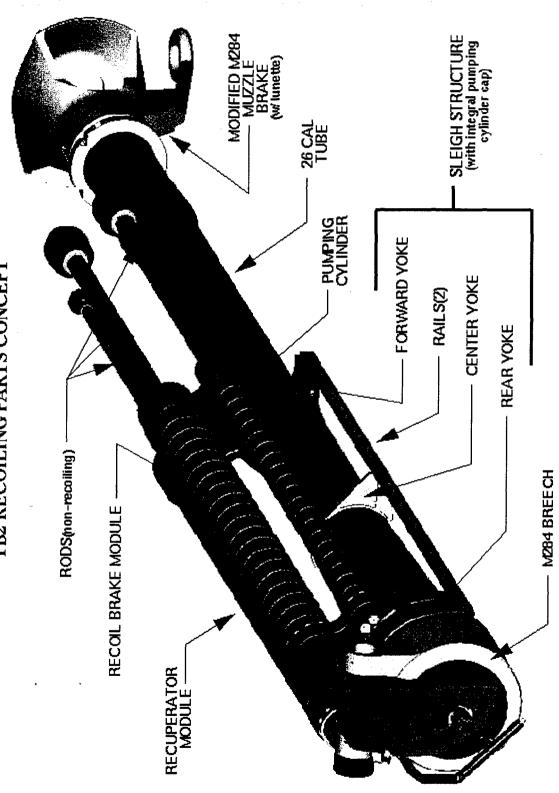


ARDEC

- Suspensions of particles in an insulating fluid medium
- Fluids which display a significant change in viscosity with application of an electric field
- Viscosity change completely reversible, fast response time (< 1 msec)



ADVANCED TECHNOLOGY LIGHTWEIGHT ARTILLERY SYSTEM TB2 RECOILING PARTS CONCEPT



OLUMN



Direct Support Challenge



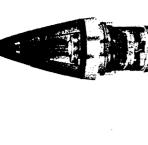
ARDEC

DENTIFY AN ARTILLERY SYSTEM CAPABLE OF PROVIDING THE LIGHT MANEUVER FORCES WITH DIRECT SUPPORT ARTILLERY WITH 155MM FIREPOWER WHILE MEETING THEIR UNIQUE MOBILITY REQUIREMENTS.

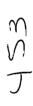
5500 LB HOWITZER Mobility

ICCM

Accuracy DIGITAL FIRE CONTROL Responsiveness



01/09/98





Jointness



Fully Coordinated Effort in Place for The Marines and Army Have a Joint Development of LW155

- and Acquisition) is the Milestone Decision Authority (MDA) Assistant Secretary of the Navy (Research, Development
- Commander, Marine Corps Sys Command Directs
- PEO-GCSS (Army Executive Agent) Executes Program
- Program Office is JOINT
- Marine PM Manages All LW155 Programs
- » Howitzer Development USMC Funds & Directs
- » P3I DFCS Development USA Funds & Directs
- JOINT Documents:
- » MNS, JORD, COEA, ILSP and TEMP



· The Future of Towed Cannon Artillery

USS

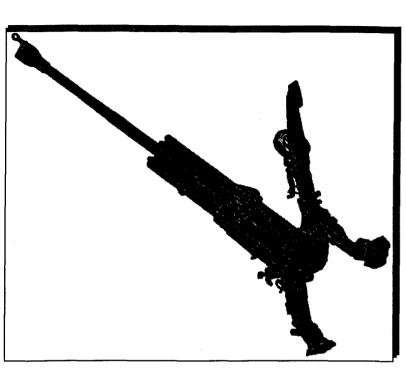
Joint Operational Requirements Document



(Signed 29 SEP 95)

M198 Capability Plus ...

- Weight 9000 Lbs or Less Deployable and Mobile
- Rate of Fire 5-8 RPM, Sustained 2 RPM
- Emplace in 2-3 Min, Displace in 1-2 Min
- **Bold Shift in 2-3 Min**
- Semi-Auto Breech & Primer Feed Mechanism
- 800 to 900 Rds Between Systems Abort
- P3l: Digital Fire Control System (DFCS)
- » Digital Indirect Fire Control
- » Inertial Navigation w/GPS
- * 1st Round Hit Direct Fire Sight
- » Powered Rammer
- » Powered Elevation & Deflection Drives
- » P3I DFCS Weight: 500 Lbs Max



The Future of Towed Cannon Artillery

LW155 Design



Lightweight High-Strength Titanium

Low Center of Gravity

Watervliet Cannon

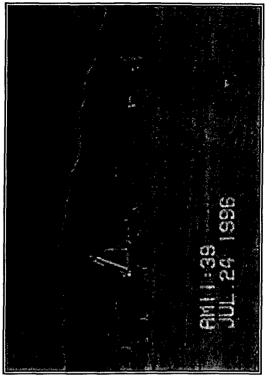


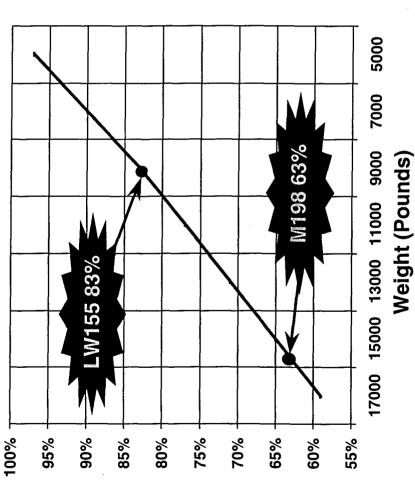


LW155 Wobility

=







% of Traversable Terrain

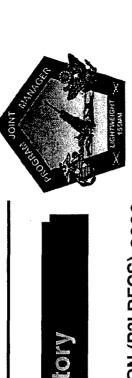
LW155 Traverses 20% More Terrain

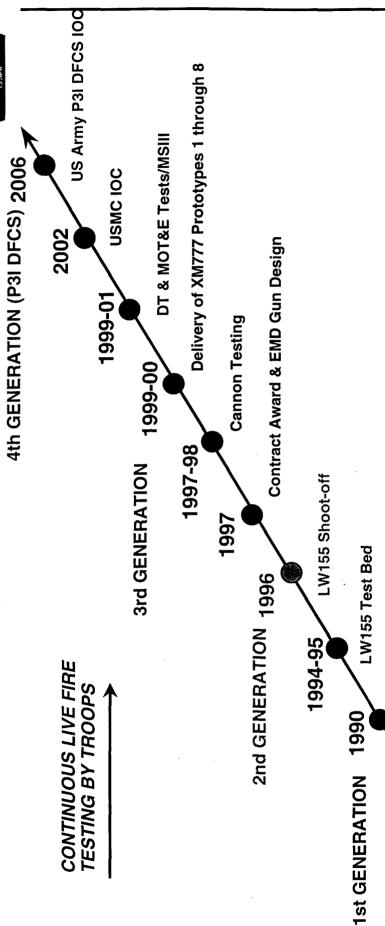
Considers SWA, NEA and Europe

The Future of Towed Cannon Artillery

XW777 LW155 Program History

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Methodical Refinement Through LW155 is Not an NDI Item Continuous Testing Concept Design

USMC & US Army Field Evaluation

1989

First Prototype Fired

1987

03 Fielding. <u> 10C</u> 05 3rd Generation Production... **Army EMD** 9 LW155 Development Path The Howitzer Program 8 66 **2nd Generation** CIME 86 RFPI AH 97 Shoot-Off II/I SIM 96 MS 0 95 1st Generation FY 94 JORD

The P3I DFCS Program

Hunter Warrior

Warrior Focus speriment/Learn

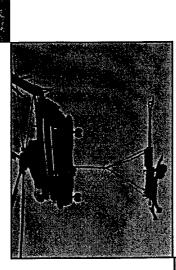
Build/Test/Field

The Future of Towed Cannon Artillery -

19T

Engineering and Manufacturing Development

- Applied Shoot-Off Lessons Learned
- Comprehensive Evaluation of 8 EMD Prototypes
- Arctic, Jungle and Desert



- Joint Marine & Army Live Fire Tests
- Detailed Logistics & Fielding Plans
- Production Preparation & Decision



FT SILL Benet Labs YPG SOFTWARE ARDEC **FATIGUE FIRING TABLES** WEAR Cannon Safety Testing ANALYSIS TEST, ANALYZE & FIX PROGRAM Live Fire 1997-1998 YPG PRE-FATIGUE (500 EFC) 2700 EFC **900 RDS** Prototype Shoot-Off #3 #2 #2 #4

#1

597

Developmental Testing

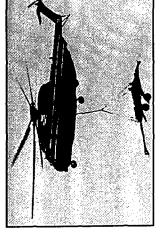
PROTOTYPE #1

- Blast Over Pressure
- Rate Of Fire
- Lifting & Tie Down
 - **Fire Control**
- **Helicopter Lift**

Hot Humid Trials **PANAMA**

- FiringMobility
- Human Factors - Reliability







PROTOTYPE #2 FT GREELEY

- Arctic Trials (Winter Freeze & Spring Thaw)
- FiringMobility
- **Human Factors**
 - Reliability







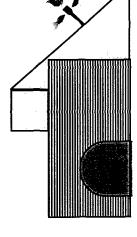
TEXTRON/PICATINNY

Log Demo

PROTOTYPE #3



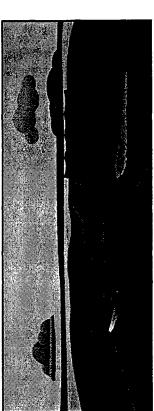




Environmental Chamber

ABERDEEN PROVING GROUND PROTOTYPE #4

- Mobility
- Hot/Cold Chamber Firing & Storage
 - Wash Down
- Rain, Ice, Sand/Dust
 - Recoil Durability
 - Rail Impact

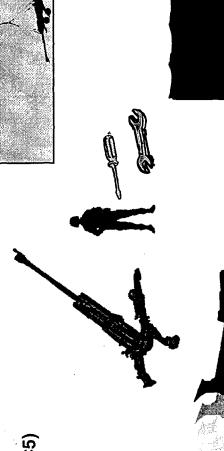


Multi-Service Operational Test & Evaluation (MOT&E)

29 PALMS/CAMP PENDLETON PROTOTYPE #5 #6 #7 #8

- Firing Missions
- > Rate of Fire
 - > Bold Shift
- > High Angle, Low Angle
- Mobility
- > Land

- TruckAAV, LAVMC-4000
- LCAC
- Other Amphibious Craft
- CH53E
- CH47D
- USAF Aircraft (C130, C141, C17, C5)

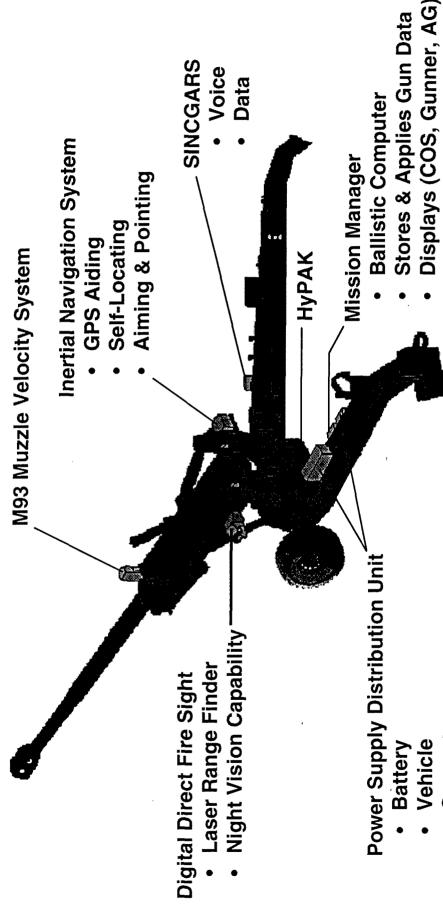


Rigorous Testing! Fast Moving! Maintenance & Maintainability

155mm Automated Howitzer



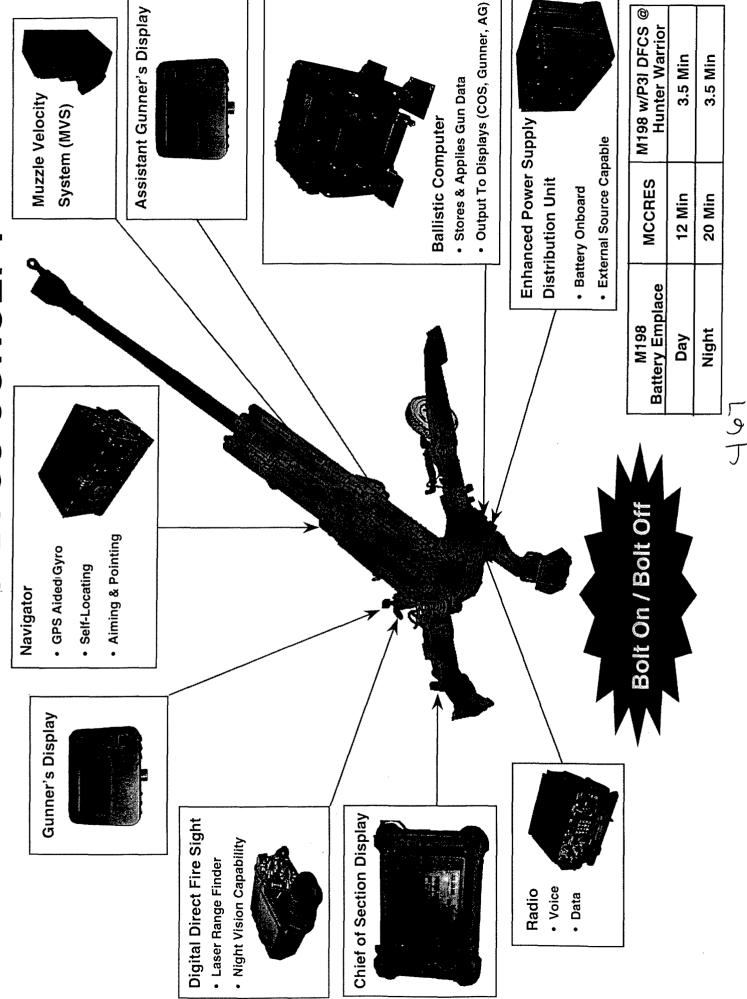
2nd Generation P3I DFCS Technology Demonstrator



Generator

The Future of Towed Cannon Artillery

XM777 P3I DFCS CONCEPT



International Involvement









- » Source Selection MOU In Place
- **EMD MOU June 98**
- Participation Planned
 Funding to US July 98
- Supplementary Test Plan
- Integrate UK into the Team Engineer Already in Place

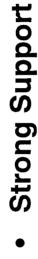
- » Formal Participation as early as Oct 98
 - Funding to US
- Major Support in Rammer Development
- Integrate Italy into the Team

International View of LW155 and P3I DFCS: **Big Stick for the Premier Light Forces**

Summary



Fast Moving Joint Program





- The Future of Towed Cannon Artillery

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A SIMULETTON BASED

NDIA Firepower Conference June 23, 1998

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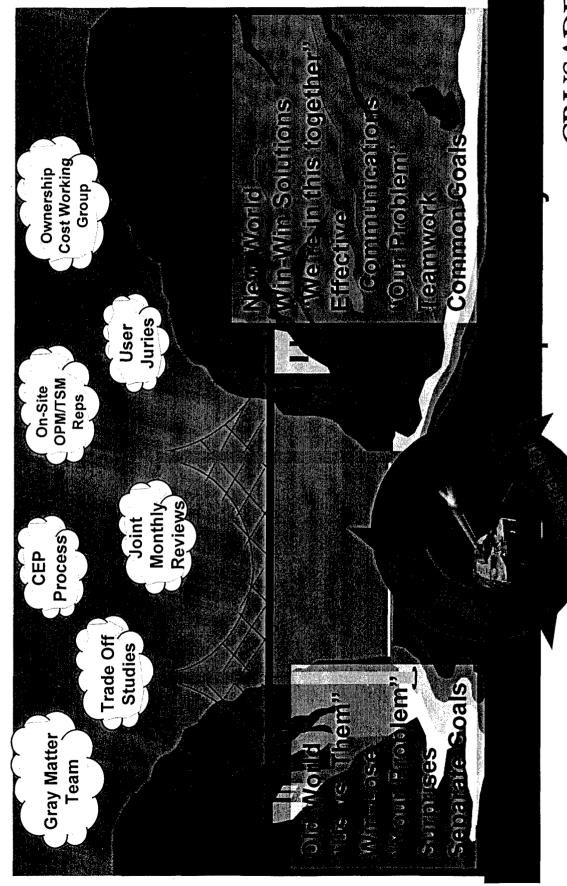
COL William B. Sheaves III Project Manager-Crusader

Mr. David K. Wallestad Crusader Program Director United Defense, LP

Inited Defense

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Development Environment Team Crusader

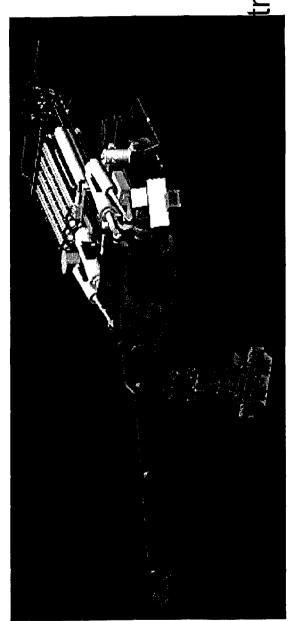


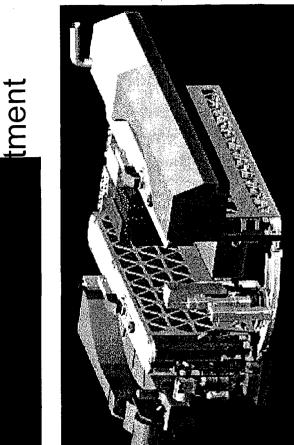
Simulation Based Development Approach **Crusader Program Challenges Drove**

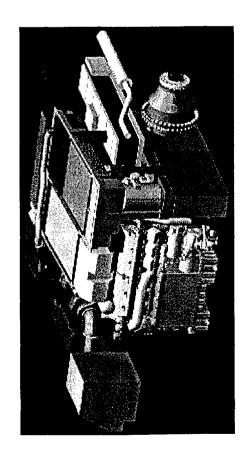
- Congressional funding cuts with no schedule relief
- Decision to abandon liquid propellant in favor of MACS
- Complex two-vehicle system with common subsystems
- Challenging system weight restrictions
- Fully automated ammunition storage, transfer, and loading
- Very high firing rates
- Revolutionary, liquid-cooled cannon system
- Compartmentalized, digital force integrated crew "cockpit"
- Improved reliability and maintainability over current Paladin system while more complex

means Of Optimizing the System Form, Fit, and Function CRUSADER ter Design Challenges Demanded A Fast and Ef

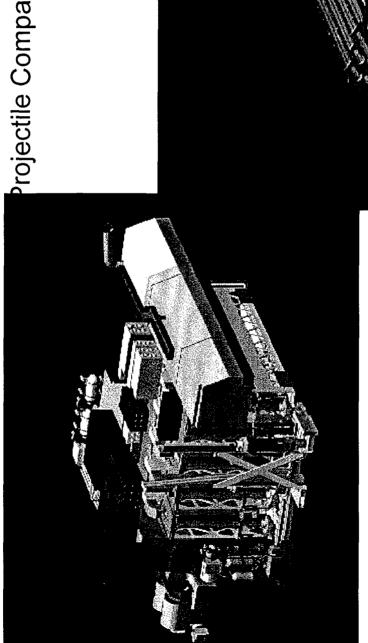
SPH Overview







Engine Compartment



Projectile Compartment

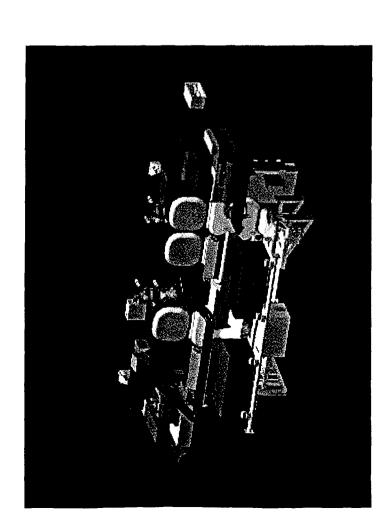
Propellant Compartment

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SPH/RSV Cockpit Overview



RSV Crew Compartment



CRUSADER

The Old Way of Doing Business

(Developer/Tester/User) and based on The development cycle was serial "Test-Fix-Test" User involvement usually began when it was time to test the hardware



Impact of Simulation Based Development

- The new development cycle is parallel (Developer+Tester+User)
- "Test-Fix-Test" still occurs but in a virtual versus a real environment

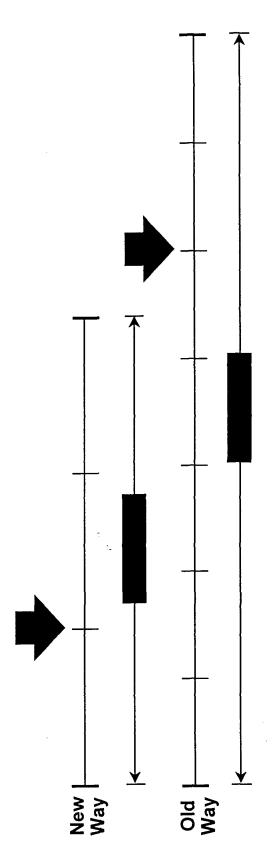


		USER TEST
		FIX
		TEST
,		BUILD
		DESIGN
		CONCEPT
		R/A
	_ 	Way I

Key Benefits

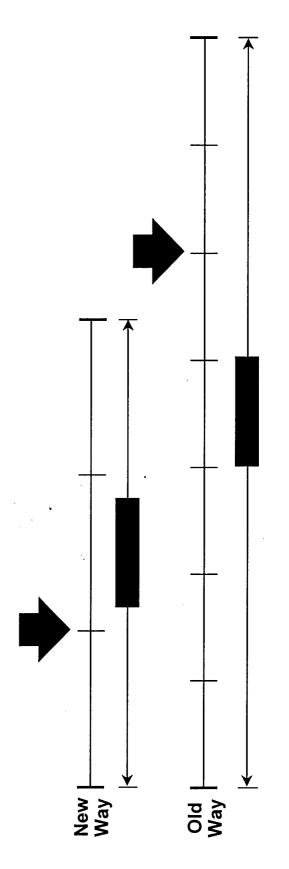
Allows the development cycle to be shortened

Establishes a high level of confidence much earlier in development that the design will satisfy the requirement



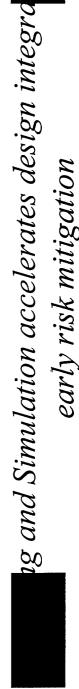
Implications

- The OPM and the User must partner with the Developer through the entire program
- databases which must be carefully managed Critical program information exists in large and readily accessible by all partners



Crusader Modeling and Simulation Uses

- Defines system behavior (Hw/Sw/Human) and performance early, and evolves with design
- Continuously integrates Hw/Sw/Human and validates interfaces
- Provides placeholder functionality to support SES development
- Supports incremental test and evaluation
- Provide visual models for understanding design (designers, customers, etc.)
- Fully integrated into the development process utilizing best available engineering data





Crusader Simulation-Based Development

Continuously Verifies and Optimizes the Crusader Design

System Integration

System Engineering

Life Cycle Support

ogram Management

S/W Architecture

S/W Integration

MANPRINT

Training

Mechanical Design Electrical Design

Test & Evaluation

Force Effectiveness Analysis

er simulation-based development concurrently and cont addresses the system's complete acquisition life cycle

Modeling & Simulation Road Map

Simulate Emulate Stimulate (SES) Integration Support Simulators/High Fidelity **Crew Station Stimulator** Models Integration S/W Tools Integrated Crusader Target S/W & HW I/O Emulation Emulator Models Rapid Prototyping Models Soldier Machine Interface Out the Window View Solid Model Simulation **Dynamic Object Model** Low Fidelity Models Visual Prototypes Mockup Scenarios & Architecture System Models Functional **Timelines** Structure Software Vehicle Model

Concept Development

Detailed Design

Preliminary Design

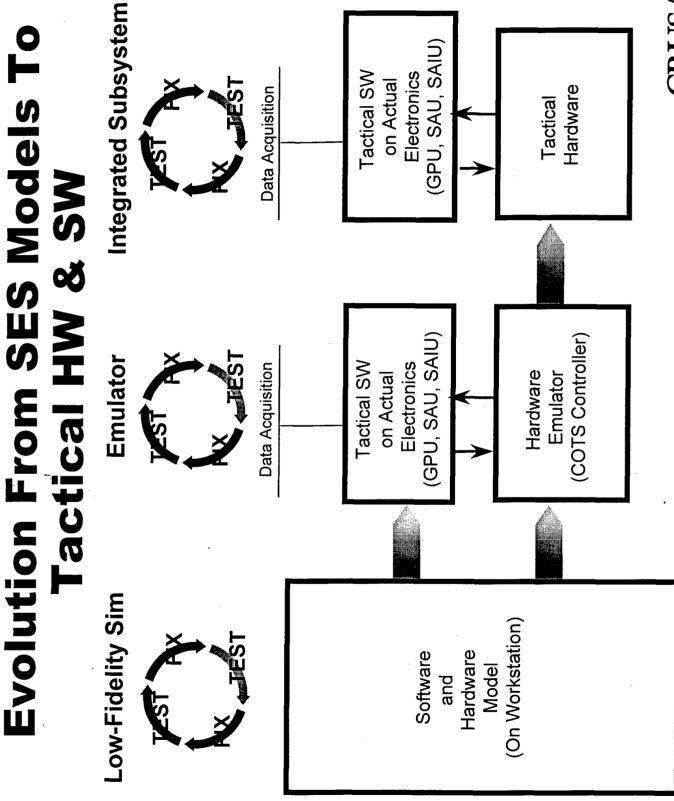
Fabrication and Test

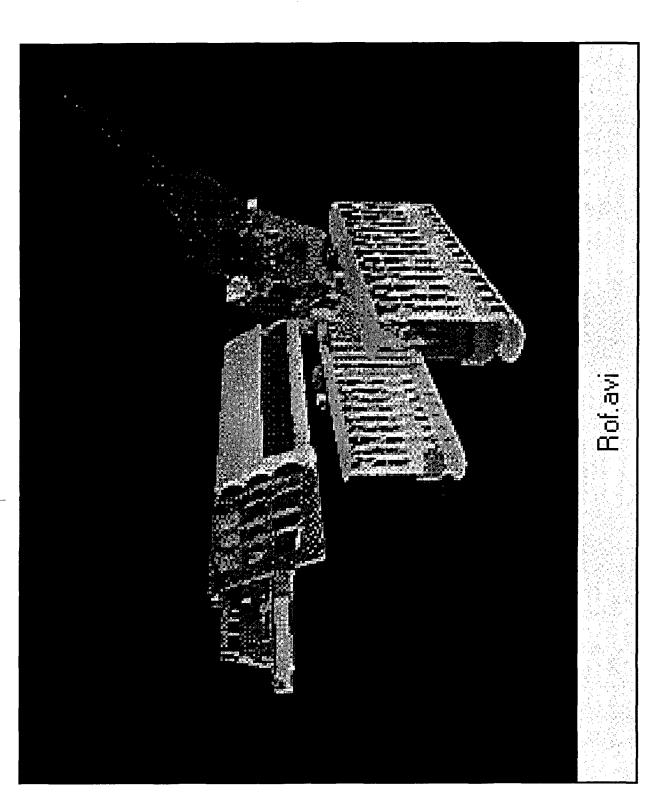
CRUSADER

Simulation-Emulation-Stimulation (SES) Process

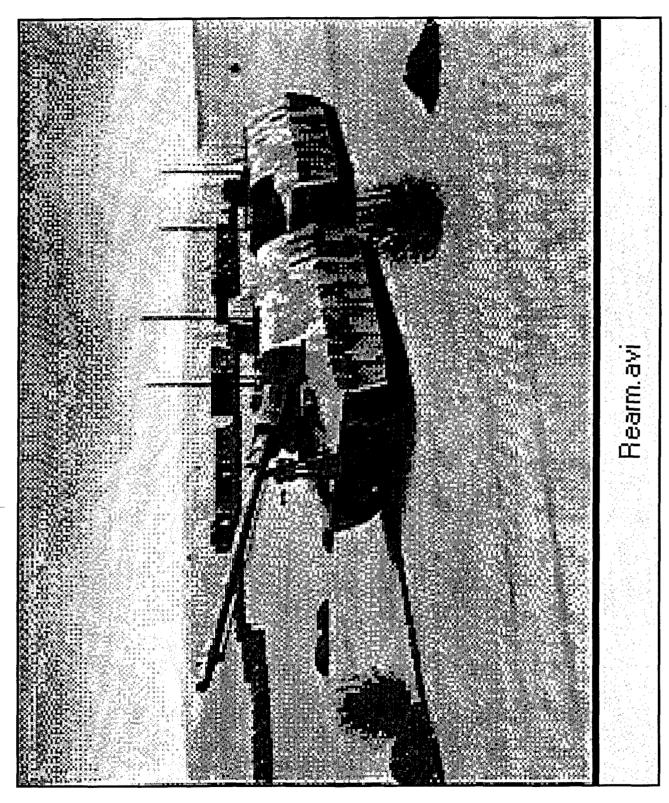
- Supports:
- Hardware Development
- S/W Development
- **System Integration**
- . Test
- Continuing Support Functions
- Evolving Process:
- Initially, purely computational...
- Then, some software and electronics in the loop...
- Finally, actual prototype hardware & software
- Incorporates user, environmental, and test inputs

ナダナ





Magazine/Conveyor/Shuttle **Brassboard Videos**



Cannon Thermal Hardstand/ROF Video

Summary

- Significant Reductions In Program Development Simulation Based Development Enables Cost, Schedule, and Risk
- Stimulation Is Necessary to Support a Maturing Approach From Simulation to Emulation to **Evolution of the Modeling and Simulation** Design
- A Successful Modeling Approach Requires:
- Partnering of the OPM/TSM/Developer
- Communicating Large Amounts of Data From An Effective Means of Managing and Many Different Sources

g and Simulation Reduces Program Cost, Schedule, a

685



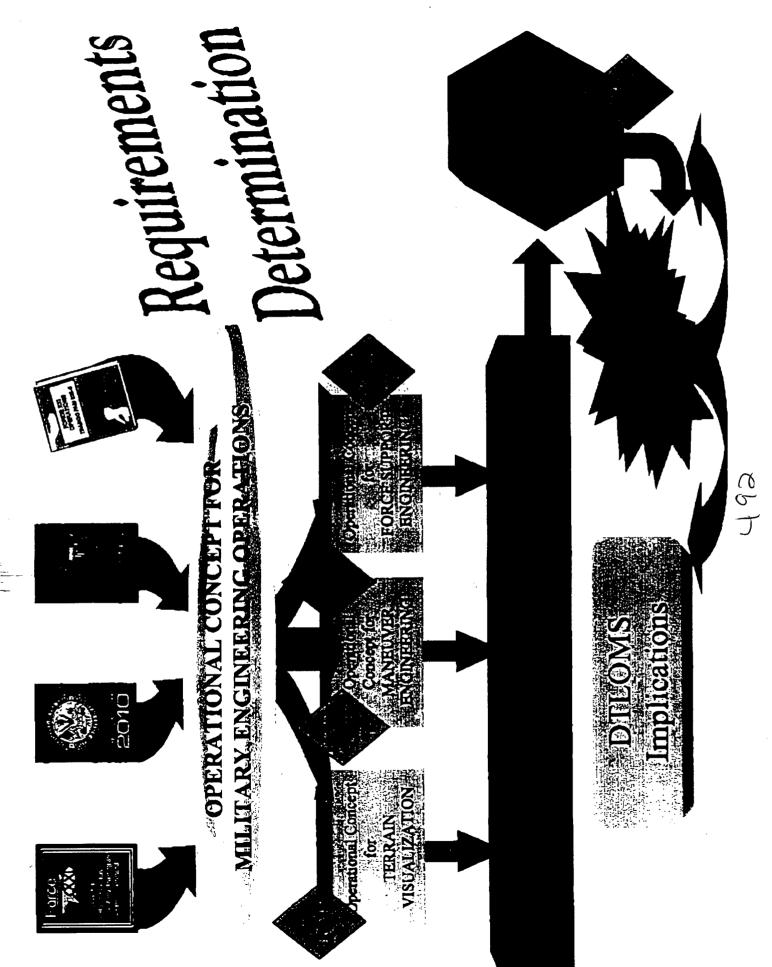
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- Trained and ready
- A Responsive and versatile member of the
- to master terrain, support the nation and Exploiting information technologies wi effective physical and technical capabil achieve decisive victory



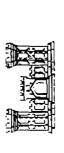
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09:49

TERRAIN VISUALIZATION



ENABLERS

DISTRIBUTE REAL-TIME **UNDERPINS ALL ABCS** *TERRAIN PICTURE* **NFORMATION**

EN ROUTE BATTLE

REHEARSAL

DEGRADATION AND OPERATIONS · VIEW ALL DIMENSIONS OF THE WEATHER, ENEMY, TERRAIN PREDICT THE EFFECTS OF BATTLESPACE

UNMANNED TERRAII TERRAIN DECISION DOMINATION ANALYSIS

UPDATE TERRAIN

COMMAND & MISSION PORTRAY TERRAIN IN

FAA 7010 11 DDC 97

567

FORCE SUPPORT ENGINEERING

· FORCE PROTECTION · HIDE THE FORCE THRU CCD CONSTRUCT FACILITIES CONSTRUCT SUPPORT CONSTRUCT ROADS & AIRFIELDS BRIDGING CONSTRUCT FACILITIES CONSTRUCT PIPELINES CONSTRUCTION · UPGRADE LOC · UNDERWATER COMMAND & MISSION **EN ROUTE BATTLE** REHEARSAL -ENABLERS

SUPPORT BRIDGING COMMON BRIDGE TRANSPORTER HDSB .

MINEFIELD REDUCTION

· PANTHER !!

· MINI-FLAIL

CONSTRUCTION EQUIPMENT

DUMP TRUCKS EXCAVATORS ROLLERS FRONT LOADERS

GRADERS

ROCK CRUSHERS **ASPHALT PLANT**

ASPHALT DISTRIBUTORS WATER DISTRIBUTORS ENGR PLS VARIANTS CONCRETE TRUCKS

SEMI-TRACTORS & TRAILERS

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SUPPORT EQUIP FIRE TRUCKS

CAMOUFLAGE **DIVING SETS**

POWER GENERATORS WELL DRILLING

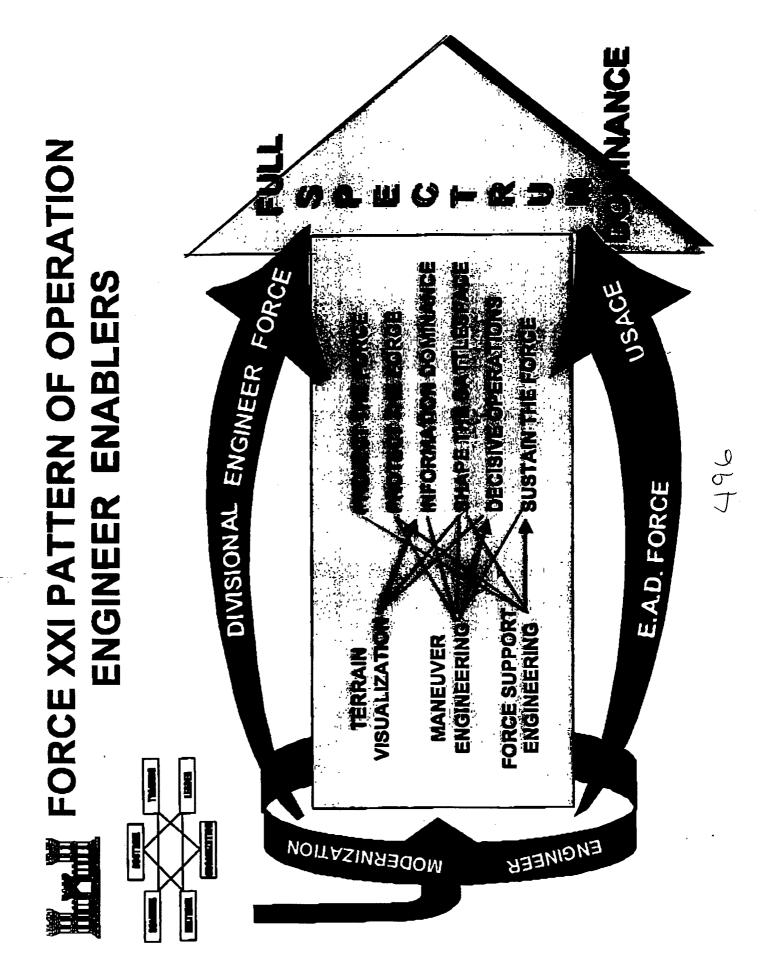
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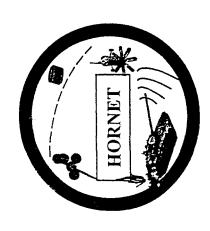
COMPACTORS

TECHNOLOGIES 11:56 [TX/RX NO 5594] 06/19/98

S6J

8 8 FAA 7012 11 DBC 97 DYNAMIC OBSTACLES **BREACH OBSTACLES EMPLACE ASSAULT** MINE DETECTION COUNTERMINE · ASTAMIDS GSTAMIDS HSTAMIDS BREACHING CONSTRUCT · GRIZZLY BRIDGING · APOBS MANEUVER ENGINEERING NAMP IVAMPO ХX · OPEN ROADS & AIRFIELDS COMBAT EARTHMOVING DYNAMIC OBSTACLES X X ACE-SIP RAPTOR · HORNET DENCE MINEFIELD REDUCTION MPROVED RIBBON ASSAULT BRIDGING **COMMON BRIDGE TRANSPORTER** · OPEN PORTS · WOLVERINE · PANTHER II · MINI-FLAIL BRIDGE COMMAND & MISSION **EN ROUTE BATTLE TECHNOLOGIES** ENABLERS REHEARSAL





HORNET WIDE AREA MUNITION

AN ESSENTIAL BUILDING BLOCK FOR ACHIEVING UNMANNED TERRAIN DOMINATION IN ARMY XXI AND BEYOND!

J. J. STAMBONI



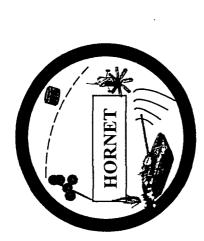




HORNET WIDE AREA MUNITION

- Emerging Requirements for Army XXI and Army After Next
- Hornet Concept of Operation
- **Equipment Description**
- **Program Status**
- How Hornet Supports Army XXI and Army After Next

7198



FOR UNMANNED TERRAIN DOMINANCE ARMY'S RECOGNIZED NEED

Army After Next 2020-25	Integrated Idea Team	Fires	Remote Deployed Dynamic Barrier	AAN WarGame
Force XXI 2005-10	Integrated Concept Team	Unmanned Terrain Domination	Hand-Emplaced Raptor	Div AWE
Today 1998-99	Integrated Product Team	WAM Hornet	Autonomous Hornet	COEA

AAN FIRES "DESIGN PRINCIPLES"

- Minimum Logistic Burden
- ·Maximum Range
- •Minimum Response Time
- ·Precision Engagement
- •Multi-functional Platforms and Munitions
- •Mix of Organic and Reach-out Assets
- Full Spectrum of Effects (Lethal to Non-lethal)
- •Minimum Collateral Damage
- Survivability (Mix Stealth, Mobility, Unmanned Platforms)
- ·Balance Man-in-the-loop Requirements
- Effective Recon-Intel-Surveillance-Tgt Acq Fusion
- ·Utility at Operational and Tactical Levels of War, While
- **Enabling Global Early Entry Operations**
- •Meet Unique Needs of Vertical Battlespace and Ingress / Egress Routes
- Supports Operations in Complex Terrain

TEXTRON Systems



IN HORNET EVOLUTION PRIMARY BUILDING BLOCKS

Remote Control Unit (RCU)

BASIC HORNET

M71

HORNET

MUNITION

~2Km (LOS)

Remote Arm / Self-Destruct Manual Arm / Self Destruct

Reset SD Time

- Hand Emplaced

- Defeats Tracked Vehicles

In Low Rate Production

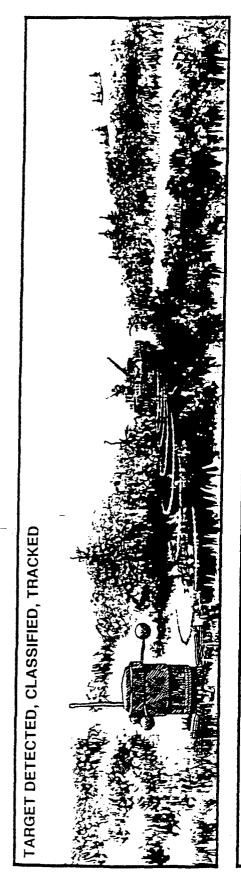
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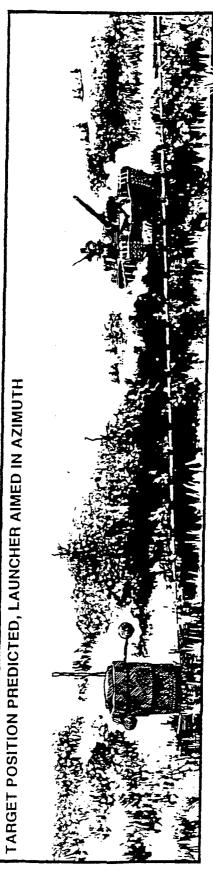
(First Deliveries 1QGFY99)

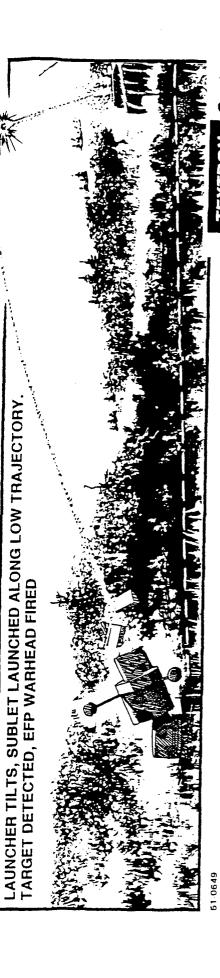
Systems

TEXTRON

WAM TARGET ENGAGEMENT SEQUENCE

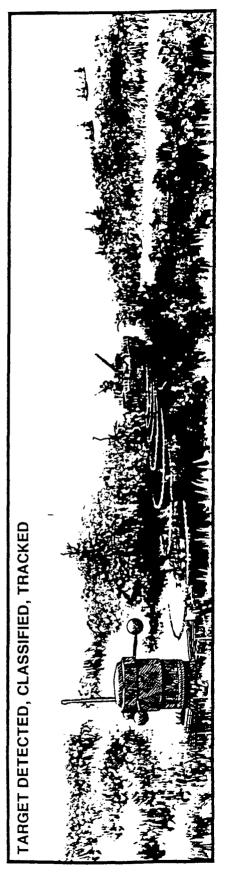


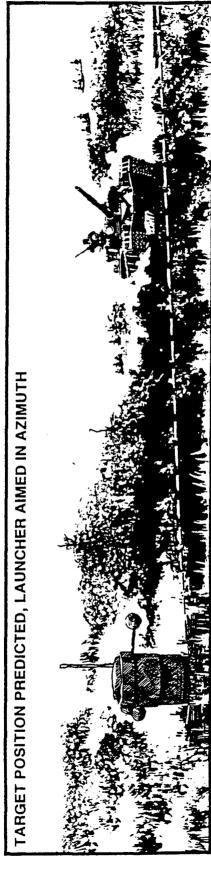


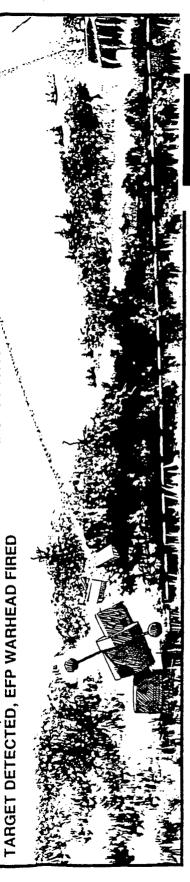


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WAM TARGET ENGAGEMENT SEQUENCE



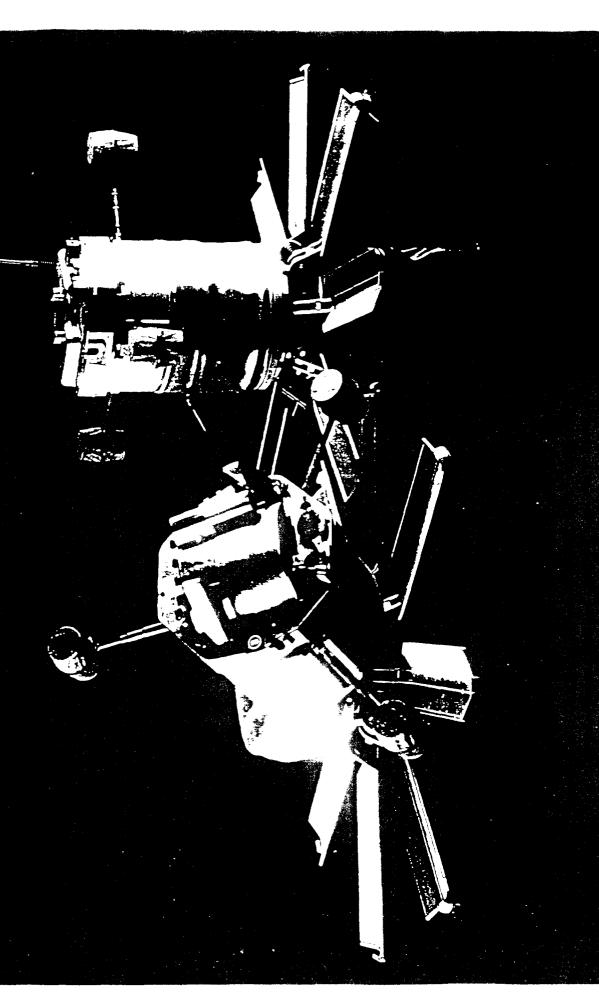




LAUNCHER TILTS, SUBLET LAUNCHED ALONG LOW TRAJECTORY

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XIRON Sy

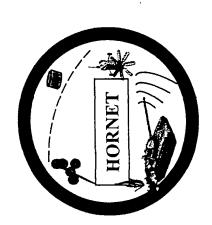


BASIC HORNET MUNITION TECHNICAL DESCRIPTION

- 35 Lb Weapon Hand Or Truck Emplaced
- Modified MOPMS Radio Receiver
- · Self Righting, Self Activating Launcher
- · Passive Acoustic/Seismic Ground Sensor
- Two-Color IR Sublet Sensor
- Tantalum Explosively Formed Penetrator Warhead

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TEXTRON Systems



AS SYSTEM EVOLVES HORNET UTILITY IMPROVES

OPERATIONAL UTILITY

HORNET BASIC

HORNET VERSION

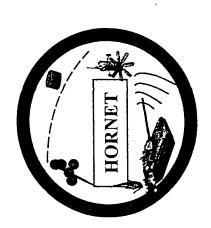
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IMPROVED HORNET

FUTURE HORNET

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IN HORNET EVOLUTION PRIMARY BUILDING BLOCKS

IMPROVED HORNET

> CONTROL STATION (HTU)

IMPROVED HORNET MUNITION

3-5 Km (LOS)

via SINCGARS



ADDS:

-On-Off-On

-Status Verification and Track Data

-Target Prioritization

-Coordinated Attack Schemes

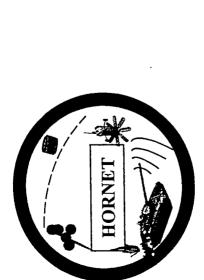
-Redeployability Prior to Arm

-GPS Location

Expanded Target Set and Off-Nominal -Performance Improvements for **Environments** In Engineering & Manufacturing Development (TC GFY 00)

TEXTRON Systems

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HORNET VERSION

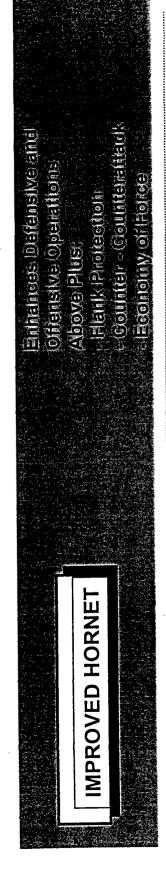
BASIC HORNET

HORNET UTILITY IMPROVES AS SYSTEM EVOLVES

OPERATIONAL UTILITY

Enhances Defensive Operations

- Overwatch of Static Obstacles
 - Approach Route Interdiction
 - Area Denial
- Economy of Force



FUTURE HORNET

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TEXTRON Systems

TECHNOLOGICAL ENABLERS FUTURE HORNET

SUBSYSTEM

·Munition Sensor Fuzed Warhead ·Munition Ground Platform

·Multi-Sensor Fusion

•Multi-Sensor Fusion and (Munition-to-Munition) Multi-node Data Fusion

Detectability of Low Contrast Targets

PAYOFF

TECHNOLOGIES

Counter-measure Immunity Lethality Against Soft Targets

·Multi-Mission Warhead

•Munition Effectiveness

 More Sophisticated Coordinated Improves Effectiveness of Field Attack Capability

Improve Accuracy of Targeting Data

•Munition Effectiveness

·Increased Munition Footprint / Reach

Systems TEXTRON

UTILITY TO DEEP MISSIONS TO EXPAND FUTURE HORNET SYSTEM LEVEL MODIFICATIONS NEEDED

Long Haul Communications Challenges

- Defining Requirements
- Best Technical Approach
- Integration Into Upper Echelon of Army's C4I Architecture
- Synchronization Across Combat Arms
- Timelines for Cueing and Targeting of Indirect Fire
- Integration With Maneuver Commander Concepts of Operation
- Remote Delivery / Deployment
- Helicopter

- UAV

MLRS

- TMD

- ATACMS

- Tomahawk
- Powered GPADS-L Parafoil
- Other

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TEXTRON Systems



AS THE SYSTEM EVOLVES

HORNET UTILITY IMPROVES

ORNET WERSION

OPERATIONAL

UTILITY

BASIC HORNET IMPROVED HORNET

Defensive Operations Enhances

Enhances

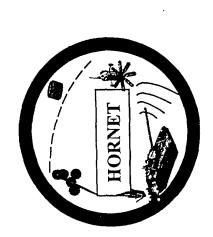
Enhances Defensive and Offensive Operations

Conclement Mines Salon Frederic Estatute and Estate FUTURE HORNET

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HORNET EVOLUTION IS SYNCHRONIZED WITH ARMY XXI TIMELINE

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BASIC HORNET	TC-LR		TC-STD	Q						
Linn						-				
FRP										
IMPROVED HORNET EMD	■agi				▲					
PRODUCTION										
FUTURE HORNET (Textron Vision)						· · · · · · · · · · · · · · · · · · ·				
TECH BASE		And the second s	A Comment of the Comm							
RISK REDUCTION										
EMD			•				Annual Commence of the commenc	A transfer company on the property of the contract of the cont	And the second s	
PRODUCTION									And the Control	The second second second
								TEXTRON	ь	Systems



Emerging Army Operational Concept

·Focusing with Intelligence

•Killing with Fires

·Finishing with Maneuver

From TRAC-FLVN (draft) post-exercise assessment of Division Advanced Warfighting Experiment (DAWE), 4th Infantry Division, November 1997

Two out of Three for Hornet ... Not bad!

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TEXTRON Systems





HORNET'S EVOLUTION AAN FIRES "DESIGN PRINCIPLES" ARE BEING FACTORED INTO

1			
·Minimum Logistic Burden	 Maximum Range 	·Minimum Response Time	

Precision Engagement

•Multi-functional Platforms and Munitions

Mix of Organic and Reach-out Assets

Full Spectrum of Effects (Lethal to Non-lethal)

·Minimum Collateral Damage

Survivability (Mix Stealth, Mobility, Unmanned Platforms)

• Effective Recon-Intel-Surveillance-Tgt-Acq Fusion Balance Man-in-the-loop Requirements

·Utility at Operational and Tactical Levels of War, While

Enabling Global Early Entry Operations

·Meet Unique Needs of Vertical Battlespace and Ingress / Egress Routes

Supports Operations in Complex Terrain

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TEXTRON Systems



HORNET

Basic Hornet Delivers A Needed Warfighting Capability Today

- Improved Hornet Will Give Substantial Increase To The Offensive And Defensive Utility of Hornet by the Year 2001
- The Technologies Exist (Many Have Been Demonstrated) For Further Expanded Utility of Hornet

Textron Is Ready To Support The Army
With Its Integration Of Hornet Into Army XXI
and Beyond





INTELLIGENT COMBAT OUTPOST (ICO) "RAPTOR"

"Armaments for the Army of the Future" NDIA Symposium

23 June 1998

Presented By: Mr. Richard Wagner

Fire Support Armaments Center ATTN: AMSTA-AR-FSP-I Picatinny Arsenal, New Jersey 07806-5000

Phone: 201 - 724 - 7838, FAX: 201 - 724 - 2501, DSN: 880 - EXT E-MAIL: <rwagner@pica.army.mil>

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BRIEFING CONTENTS



- Concept Description
- Raptor Benefits
- **System Description**
- Development Plan
- Program Schedule
- User Comments



WHAT IS RAPTOR?



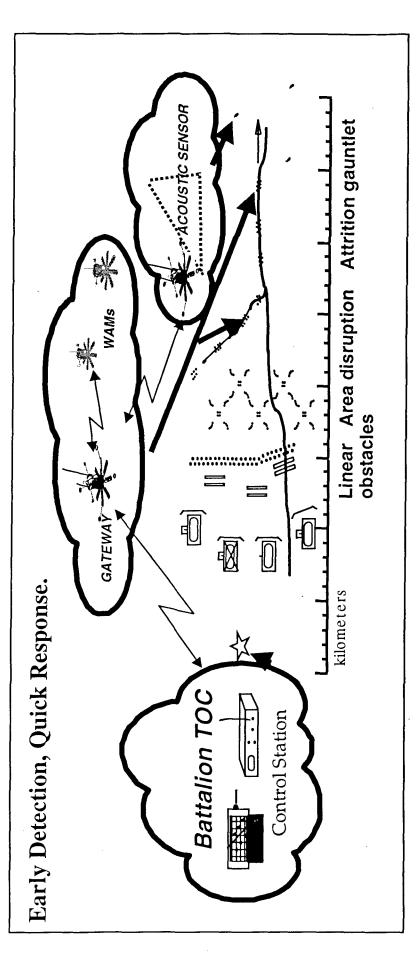


awareness and targeting information to the A smart, autonomous, anti-armor/vehicle system which also provides situational WAMs and other shooters.



THE VISION





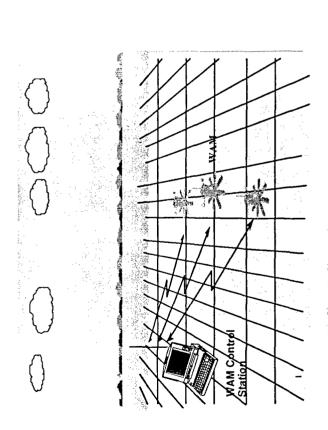
Disrupt, Fix and Attirit the Enemy Deep



RAPTOR SOLUTION

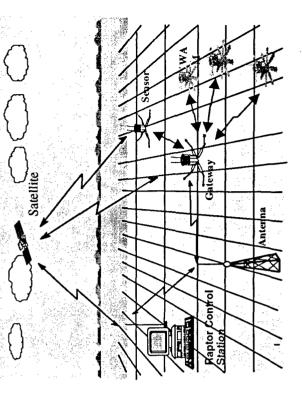


and Sensors to Non-Line-Of-Sight Extend C2 Range of WAM Fields





WAM PIP

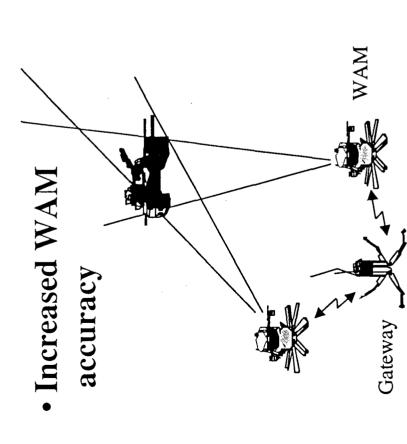


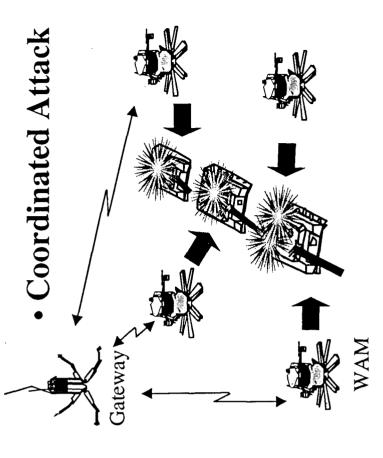


RAPTOR SOLUTION



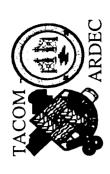
Increase WAM Effectiveness by Networking with a Gateway







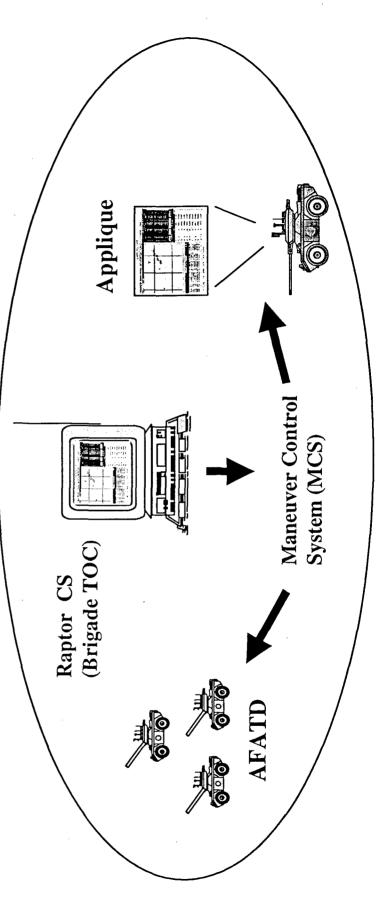
RAPTOR SOLUTION



Increase Target Engagement Opportunities

Target Info to Other Shooters

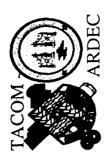
Situational Awareness





SYSTEM COMPONENTS



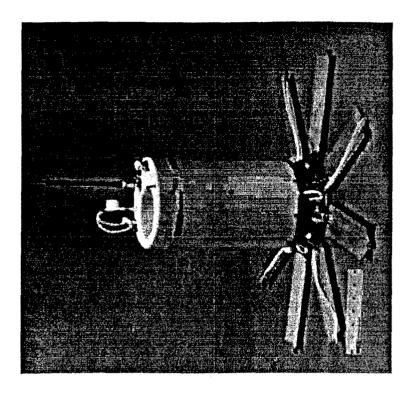




- Coordinates WAM Attacks
- Improves Individual WAM Performance
- Extends WAM C2 Commo Link



- Avg 50% Better WAM Perf.
- · Coordinated Munition Attack





SYSTEM COMPONENTS Overwatch Sensor

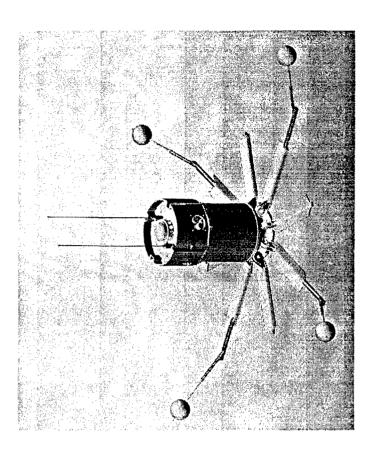




- Early Warning for Munitions & Tactical Operations
- Target Info for Long Range Shooters/Hunters

Demonstrated

- Track 7 Targets
- Detect Vehicles at 2-4 km





SYSTEM COMPONENTS Control Station





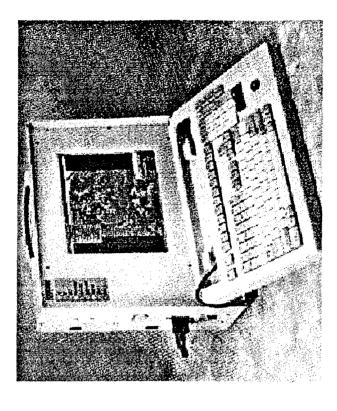
 Situational Awareness (target data feeds) to Brigade Tactical Operations Center

- Engineers

-Maneuver

- Intelligence - Artillery

-Aviation



Demonstrated

- Remote C2 of Multiple Gateways/Fields
- Displayed Area Activity
- · Transmitted Intelligence to the Maneuver Control System

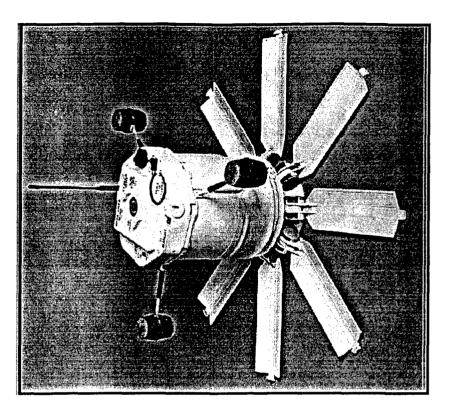


SYSTEM COMPONENTS Wide Area Munition





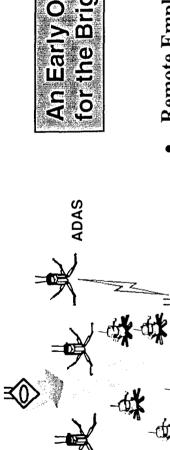
- Passive Target Detectors
- Formed Penetrator Warhead Top Attack, Explosively
- Autonomous target Engagement
- In Low Rate Production





RAPTOR CORE SYSTEM





An Early Operational Capability for the Brigade Commander

- Remote Employment
- $\Rightarrow Up \ to \ 50 \ Kilometers from Control Station$
 - ⇒ Delivered by Helicopter, Hand Emplaced

Hornet PIP

- **Extended Communications**
- ⇒ Multiple Ground and/or Aerial Communication Relay

30 - 50 km

- Targets (detect, classify, track/locate, attack)
- ⇒ Heavy Wheeled and Tracked
- \Rightarrow Light Wheeled and Tracked

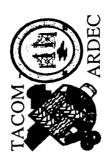
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A Force XXI System



RAPTOR OBJECTIVE SYSTEM



Full Operational Capability for the Corps and Division Commander

- Deep Operations
- \Rightarrow 50-300 Kilometers

Zrezusion Strike

- ⇒ Deployed by Powered Parafoil or Airdrop
- Long Range Communications
- ⇒ Satellite or UAV Communication Relay

Economy of Force

- ⇒ Near Real Time Communications
- ⇒ Enables Artillery Calls for Fire
- Targets (Core targets + sense and report)

50-300 km

- ⇒ Low Flying Aircraft
- ⇒ Artillery/ Missile Firings
- IFF Capability

Force XXI and Beyond

8°5



RAPTOR SCHEDULE



SCHEDULE (MILESTONE / ACTIVITY)

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Core Production-CORE	tive EMD-Objective
Engr & Mfg Dev-	PDRR-Object
Prog Def & Risk Reduction- Core	

△ Requirements Document Approved△ MILESTONE I

Objective

△ Award Contract

△ Engr, Mfg & Dev Contract Award

△ MILESTONE II

△ MILESTONE III CORE SYSTEM

△ Award Production Contract Core System

FIRST UNIT EQUIPPED CORE SYSTEM



What Soldiers Say About Raptor





- Brigade Commander

"We love it—it's not just intel, it's a killer"

- Brigade Commander

"Raptor is very important to maneuver forces and

- Division Staff Officer

"Son of WAM — Raptor—that's a good system. We are looking forward to it"

- Artillery Commander

"A squad can put in a Raptor obstacle in an hour that would require a platoon six to seven hours using mines."

· Division Engineer

Bottom Line: The Troops Need Raptor



Greg Colombo- Biography for NDIA Symposium:

Mr. Colombo has been on the Intelligent Minefield/Raptor program for the past 3 years at ARDEC. He was the Intelligent Minefield ATD manager 1995-1997 and was previously a group leader on the Electric Gun program for 10 years. Mr. Colombo graduated from Fairleigh Dickinson University, at Teaneck, NJ in 1983 with a Bachelor of Science in Mechanical Engineering degree.

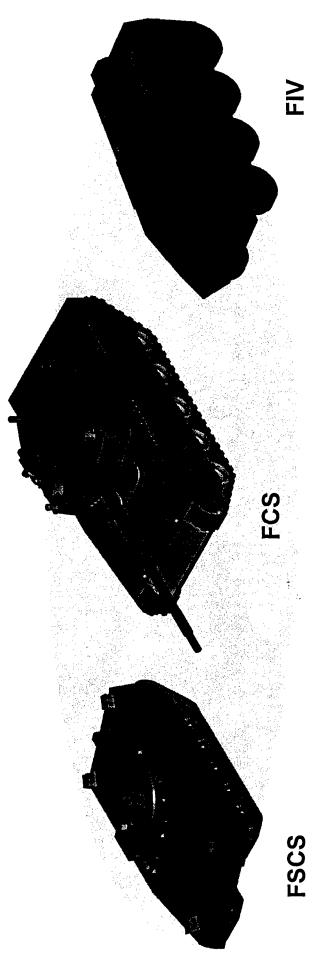






Mobility and Firepower for America's Army

Advanced Vehicle Development



NDIA/ARDEC Firepower Symposium

24 June 1998

J.L. Chapin

Director, TARDEC

86/6/9

Tank-automotive & Armaments COMmand



Outline



- Requirement

- Recent Events

Critical Technologies

Lethality

Future Combat System:

- Operational Goals

- Process

Future Infantry Vehicle

- Requirement

Update

Summary



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Requirement

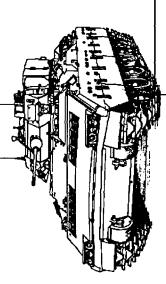


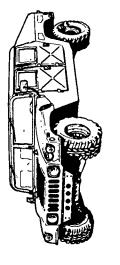
WHY GROUND SCOUT?

- Continuous Operations
- All Weather Capability
- Unaffected by Air Defense
- On-site Human Judgement
- Physical Retrieval of Materials
- Complements Aerial Sensors

CURRENT CAPABILITY SHORTFALLS

- No Long-Range Detection and Identification Capability
- Easily Detected on the Battlefield
- Unable to Integrate External Intelligence, Surveillance, and Reconnaissance Information for Mission Accomplishment
- Inadequate Ballistic Protection and Mobility (HMMWVV)
- Limited Deployability (Bradley)





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Recent Events



- National Approval Process:
- US Complete: 26 Feb 98
- UK Complete:
- · Memorandum Of Understanding (MOU) Signature:
- Invitation To Tender (ITT) Release:
- US Technology Transfer / CODEWORD Spec Release:
- Combined Analysis Plan JSAG Meeting: 12 May 98
- Modified CSTAR Release to Industry: 27 Feb 98
- Final CSTAR Release to Industry: Jul 98
- FSCS Doctrine Briefings to Industry: UK 15 Jan 98, US 26 Feb 98
- Initial US/UK IPPD Training: 12-15 May 98



WORK ONGOING

COOPERATIVE PROGRAM Combined ORD Harmonized Specification Harmonized

EFFORT ON TARGET



FSCS ATD Fast Track Strategy



- · Design, Develop and Build a Demonstrator
- Demonstrate Technical Feasibility and Maturity of Subsystems
- Evaluate Technical Performance and System Integration
- Validate/Refine Requirements and Specifications Prior to EMD
- Address Early Management of Risk
- Address Affordability Early
- Early S&T, PM & PEO Teaming
- · Transition to PEO 18 Months Before end of ATD Phase to Develop Documentation & Plans for MS I/II for EMD
- Reduce Time and Cost over Traditional Acquisition Program
- · Demonstrate at end of ATD Phase that Program is Ready for EMD

DO THE RIGHT THING, DO IT ONCE, DO IT STRAIGHT TO EMD

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Benefits Of Cooperative Program



- Provides Affordable Competition
- Adds Program Stability
- Creates Broader Pool Of Technology Options
- Adds Production Economies Of Scale
- Avoids Duplicative Programs
- Promotes Interoperability
- Provides Cost Savings
- Establishes Potential For FMS
- Enhances Political Cooperation



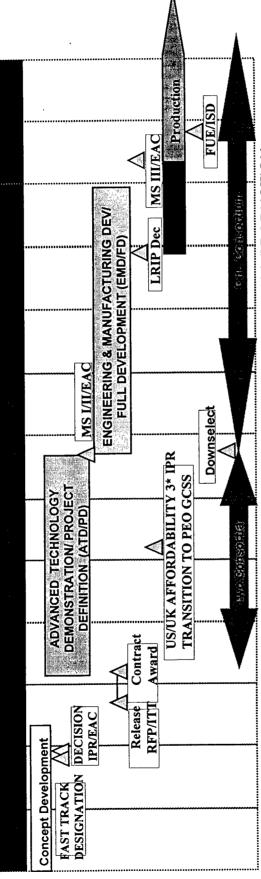




Acquisition Strategy

TRACER/FSCS PROGRAM SCHEDULE





- COOPERATIVE US/UK DEVELOPMENT & PRODUCTION FAST TRACK ATD TO EMD 4 PHASE PROGRAM
 - US/UK CONTRACTOR CONSORTIA AS PRIMES
- PHASE I (ATD/PD)
- · COMPETITIVELY SELECT TWO (2) US/UK CONSORTIA
 - GOVT/CONT IMPLEMENT IPPD · US/UK 50/50 COST SHARE
- BUILD & TEST ONE FULL-UP DEMONSTRATOR PER CONSORTIA TEN PROTOTYPES
 - 42 MONTH PERIOD OF PERFORMANCE
- PROVIDE MINIMUM SUSTAINING EFFORT UNTIL FULL RATE PHASE III (LRIP) **PRODUCTION**
 - SUPPORT FUE NLT 07
- · CONTRACTOR CONFIGURATION CONTROL

PHASE IV (FULL RATE PRODUCTION) AFTER SUCCESSFUL MILESTONE III, IPT, LFT, IOT&E

52 MONTH PERIOD OF PERFORMANCE

EMD AWARD WITH OPTION FOR PRODUCTION

DOWNSELECT TO ONE US/UK CONSORTIUM

US/UK 50/50 COST SHARE

PHASE II (EMD/FD)

- PRODUCTION CAPABILITY IN BOTH NATIONS

 - QUANTITIES US 1239, UK 335



Critical Technologies



SENSORS

- Mast Mounted FLIR with **Extended Range Optics**
- •Multi-Function Laser
- Acoustic Sensors
- Active Emitter

Signature Management

•HTI Hit Avoidance

Armor

SURVIVABILITY

MOBILITY

- Electric or Conventional Drive
 - Semi-active Hydropneumatic Suspension Band Track

ARMAMENT

SYSTEM/DEPLOYABILITY

•Multi-band, Multi-mode Radio Open Electronic Architecture

C4I/ELECTRONICS

Advanced Crew Station

Fully Integrated into Digital

Battlefield

- Advanced Structure
- Hybrid Power System

- Medium Caliber Weapon
- Advanced Fire Control



LETHALITY



KOBY PORTORANKOD PARANDITOR



Medium Gun (for Self Defense)

- -Non Crew Served
- -Defeat the Primary Light Armored
- -Growth Potential

Vehicle Threat

-Armor Piercing & GP Rounds

Secondary Armament

THE FSCS/TRAGER VEHICLE IS REQUIRED TO MOUNT WEAPON SYSTEMS THAT PROVIDE A SELF DEFENSE CAPABILITY WITH GROWTH POTENTIAL THROUGH THE LIFE OF THE VEHICLE"



Technical Challenge: Lethality



Technical Challenges

- Selection of medium caliber weapon system:
- Capable of defeating the primary Light Armored Vehicle threat.
- Will have growth potential to defeat future Light Armored Vehicle threats (2016 time frame).
- Capable of defeating secondary threats such as infantry with body armor and defensive structures.
- Integration of medium caliber weapon system:
- Minimize weight, volume & intrusion.
- Optimize ready and stowed rounds to satisfy performance requirements.

Approach

- Identify and assess the optimum armament system components in virtual environment including:
- Bursting munition technology
- Advanced KE warheads
- Gearless electronic turret stabilization
- Full solution fire control
- Mature 6.2 components and NDI technologies to ensure low risk transfer (e.g. automatic loading technology)





Lethality Options



Objective

- · Provide the FSCS with an "NDI" (IR&D) medium cannon solution
- Contractor funded development
- Low level government "investigations" on-going
- Program to select from two options
- CT 2000 (cased telescope round)
- Bushmaster III (conventional round)
- Potential demonstration of remote weapon station Integration

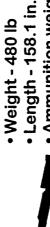
Program Status

- Bushmaster III
- Demonstrated in Bradley turret at ARDEC 4QFY97
 - Demonstration and testing at APG, 2QFY98
- Linkless gun and feed system testing, 3QFY98
- CT 2000
- Successfully demonstrated gun, ammunition, and ammunition handling system at 45mm
 - Planned demonstration at 40mm in 1998

CT 2000

- Weight 580 lb
- Length 142.6 in.
- Ammunition weight 3.3 lb/rd
 - Firing rate 1-200 rpm
- Push through rotating chamber

Bushmaster



- Ammunition weight 3.45 lb/rd
 - Firing rate 1-200 rpm

Technical Approach

- Bushmaster III
- Scale-up proven chain gun technology to 35mm
- Leverage existing 35mm ammunition development
 - Growth potential (50mm) using CTA technology
- CT 2000
- Scale-down demonstrated 45mm approach
 - Tank gun velocity and accuracy
- 50% less parts than conventional system
- Modular autoloader handles two round types in linkless modular design



Industrial Teaming



Two Anglo-US Consortia Formed:

SIKA INTERNATIONAL

British Aerospace
Lockheed Martin
Vickers Defence Systems
General Dynamics-Land Systems

8

LANCER

GEC-Marconi United Defense Limited Partnership Raytheon-TI GKN



FCS Operational Goals



Lethality

Defeat all known & projected Threats

Survivability

Tank level protection without heavy armor

Mobility

Greater speed and mobility-all terrain and all weather

Fightability

Reduced crew operation/Situational Awareness

Deployability

(1) FCS per AAN Advanced Air Transport

Sustainability

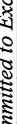
50-75% reduction in Class III, V IX over 30 day mission

(Self sufficient for 48 hours)



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Future Combat System



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- Draft Mission Need Statement (July '96)
- Chartered FCS S&T Director (Oct '96)
- Advanced Concept Exploration
- Thru ICT's, Working Groups, Modeling & Simulation
 - Identify High Payoff Operational Capabilities
- Focus Technology Development
- Explore Options to Leverage Other System & Technology Development
- Primary System Drivers
- Strategic & Tactical Mobility
- Overwhelming Lethality
- Initial Lethality Integration Study Completed (Aug '97)
- Current 20 Ton Studies

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FIV Requirement



Lethality

Provide direct fire support to dismounts

Survivability

Protect crew and dismount against NBC, small arms, medium caliber cannon, anti-armor weapons, mines and directed energy weapons

Mobility

Greater speed and mobility-all terrain and all weather

Fightability

Transport a complete infantry squad

Deployability

Improved deployability by air, land, and sea

Command and Control

Share information seamlessly with other FCVs/FIVs in section, platoon, and as well as other combat and C3I systems

Medium Family of Vehicles Approach



FIV ICT Update



•March 96: FIV MNS Completed World Wide Staffing

5 June 96: FIV ICT Chartered by CG USAIC

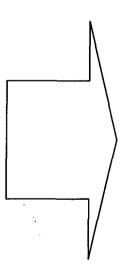
5 June-Dec96: ICT Developed MNS

•23 April 97: TRADOC Approved FIV MNS

•15 August 97: TRADOC Authorized USAIC to Establish FIV (Family of Medium

Vehicles) ICT

•14 April 98: USAIC FIV Briefing to LTG Abrams



FIV ATD: 2002-2006 FIV FUE: 2012 Committed to Excellence

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Summary



-SCS:

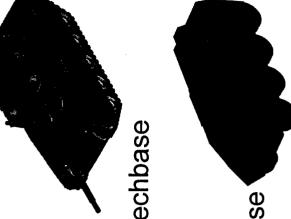
- New Start Cooperative International Program
- Strong US/UK Support for ATD Phase
- Fast Track Approach
- Technology Bridge to AAN

FCS:

- Focus on Army After Next
- Techbase & Operational Requirements Definition Modeling & Simulation Needed to Focus
- Leap Ahead Performance Requires Investment in Techbase <u>~</u>







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• Backups





Other Significant Events



Deputy Assistant Secretary Of Army For Research And Technology, Dr. Fenner Milton, Approves FSCS ATD Management Plan

10 Nov 97

· Section 27 Certification Submitted To Congress

23 Dec 97

OSD Acting Director Of Defense Research And Engineering, Mr. George Singley, Endorses Program

7 Jan 98

OSD Affordability Task Force FSCS Program Review

7 Jan 98

Determination & Finding Signed By Dr. Gansler

19 Feb 98

86

Aug

Return Of Offers/Tenders

Nov 98

SSEB/Tender Assessment Complete
 UK National Contract Award Process

Nov 98 Dec 98

Contract Award

Dec 98

Start Of Work Meetings

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DRAFT FSCS CORD AND THE **ARMY AFTER NEXT (AAN)**



FSCS DRAFT CORD

- ■Advanced Multi-Spectra Sensors
- Staring Array, Acoustic, High Res Sensors
- Auto/Aided Target Detection/ID
- Absolute Overmatch into the Future

AAN EMERGING CHARACTERISTICS

Smart Sensors Information Based Precision Maneuver & Precision Strike

Enhancement Performance Human Detection / ID **Aided Target**

> Operations **Dispersed Tactical**

Self Protection Through Movement, Organic

Embedded

Training

Management, & Situational Weapons, Signature

Integrated Defense

Precision Maneuver & Target Handoff

■Increased Survivability

- On Board Information/Intelligence Fusion

- Advanced Situational Awareness

■Next Generation C4I System

Management

Signature Control

Reduced Logistical Tail

Strategic & Operational Power Projection FSCS is the technology bridge between Force XXI & AAN

> Between Heavy and Narrow the Gap

Light

■Improved Deployability

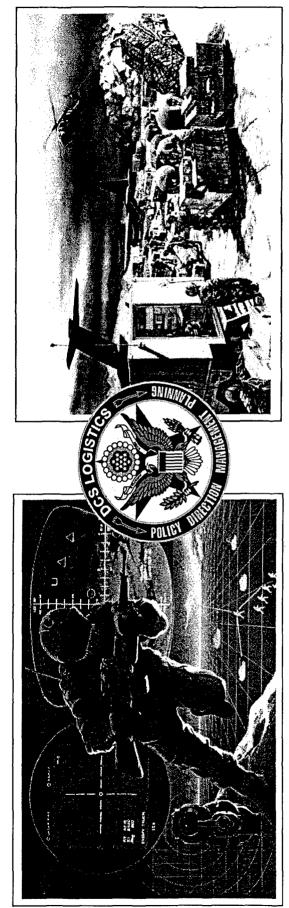
- Modular Armor/Composite Materials

- Integrated Defensive Suite

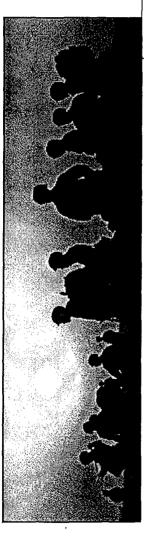
- Revolutionary Signature Management

- (1) Per C130

- (3) Per C-17



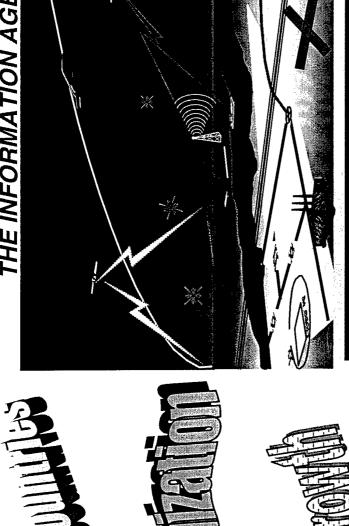
MG CHARLES C. CANNON ADCSLOG





THE FUTURE 2025 CHALLENGES

THE INFORMATION AGE



MENTAL

PHYSICA

ARE SHAPING CONCEPTS 2025

* Global Maneuver **Capability** **Asymmetric Forces**

Information Enables Precision Maneuver

* Platforms Accelerate Speed * All Support to be positioned outside the "Killing Field"... But those Forces to Move, Observe, & Kill



THOUGHTS THAT WOULD REMAIN RELEVANT

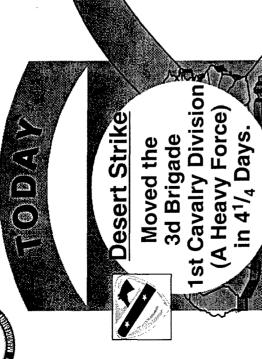
- ➤ The US Army is Not a FEDEX or any Commercial Business . . . While it can't be run like a Commercial Endeavor . . . We can Learn & Apply some Business Practices
- > Technology is a "Means or a Way" - It is Not an "End". We must keep identifying the "End"
- > In a High Technology Army, "Tooth-to-Tail" ratios may no longer be applicable



- ➤ We must continually rethink the role of Organic, Joint, & Industry capabilities in satisfying our future requirements
- ➤ The future Force will be a combination of Army XXI legacy & evolving AAN units

SUPPORTING SOLDIERS





By C+ 2 to 5

Desert Thunder
... Could have
closed Hvy Bde
in 96 Hours!

The Difference <u>Today</u> is Army Prepositioned Stocks





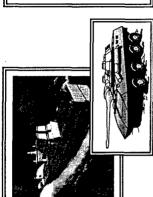
2025 MISSIONS WILL DEMAND GREATER RESPONSE TIMES

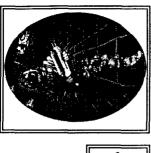
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2025 REALITIES

- > By 2020, projected World's largest economies in order are: China, U.S., Japan, India, & Indonesia
- ➤ Economic boundaries between Nations blur
- ➤ Proliferation of WMD & Non-lethal WMD
- > Peer competitors will employ Asymmetric Threat capabilities
- > 85% of World Population Growth occurring in developing nations
- > By 2020, 25% of U.S. population over 65 . . . # of Skilled / Quality workers will decline
- > U.S. Strategy Power Projection & Strategic Dominant Maneuver
- Coalition / Alliances more important . . . but different from today
- > U.S. Information & Technology-based capabilities are vulnerable
- ▼ Mixture of AAN & Army XXI Forces
- U.S. Joint Integration of Forces
- Civilianized / contracted "Log" Force
 - "Teaming / Matrix" organizations







RML ROADMAP TO 2025

- Info Dominance
 - Maintain Combat Overmatch
- Insert essential S&T enablers

Speed / Knowledge Exploitation of

<u>-ogistics Control</u> Real Time

Adequate Log Footprimt

Distribution Based

-ogistics

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of Movement" to get inside his Execution Using the "Speed Cycle = Victory

Using Information "Decision Cycle" to get inside his

SUPPORTING SOLDIERS

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GLIMPSE OF THE FUTURE

Operational Characteristics of AAN (20XX)

. Force Projection Implications

1997 Leavenworth/TWG Findings:

- Mobility, characterized by Speed of Maneuver key to success
- Battlefield Knowledge enablers Speed of Maneuver
- / To offset "Blue" Dominance, Asymmetric responses occur rapidly
- Mixture of Army XXI Forces & AAN Forces used
- Strategic Speed:
- Moving AAN Forces within 48hrs anywhere in the world
- Moving Army XXI Forces within two weeks anywhere in the world



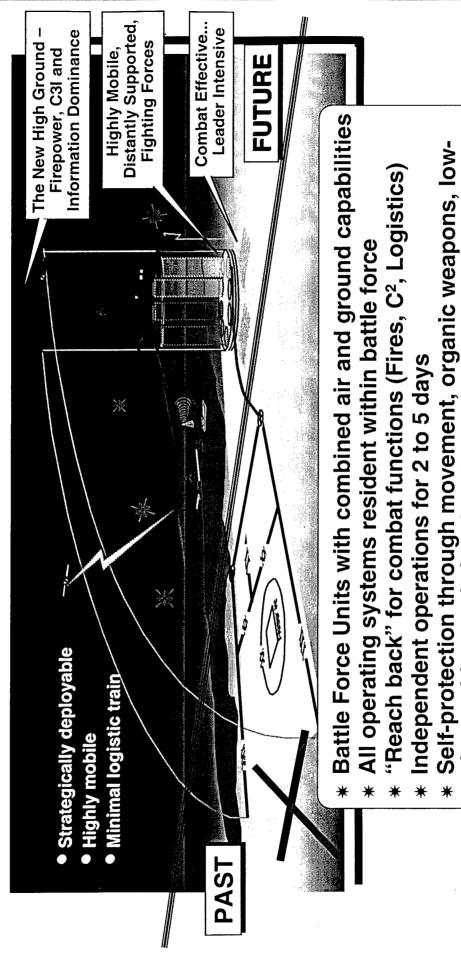
- This Means:
- Operational Forces require a "radically" streamlined Logistics Tail
- Strategic-Level Deployment requires new technologies & methods of projection (From Weeks to Days)



GLIMPSE OF THE FUTURE

Operational Characteristics of AAN (20XX)

... A Balanced Approach to Warfare



This Means:

Log Must Be Equally Mobile and Agile -- Predictive Not Reactive

observables, and situational awareness

DA DCSLOG (Army Log Support 2025) - 6/9/98



THE REVOLUTION HAS BEGUN.

PW L M Domains Doing Many Things. . . Some Examples

Technology Application and Acquisition Agility

- PLSM TS
- Em bedded prognostics/ diagnostics
- TED ANN
- ►GC SS-A
- ►C SSC S
- Batteries and A Itemative Power
- Life Cycle Cost Mgm
- IN PAC Credit Card
- JCALS

Force Projection

- Fast Sealift
- + C 17s
- + Power Projection
 Infrastructure
- *Enhanced RSO & I
 - Arm y Prepositioned Stocks
- * Arm y Strategic M obility Program
- TC AIM SI
- + JTAV
- + Joint Deployment Training Center

Force Sustainment

- ◆ A dvanced Logistics Program
- Battlefield
 Distribution
- + LOGCAP
- + FleetM anagem ent
- Interactive E lectronic
 TechnicalM anuals
- ◆ DIAL
- + DVD /Prim eV endor-Factory to Foxhole
- + Velocity M anagem ent
- * AW E Division XXI
 Logistics Concepts

SUPPORTING SOLDIERS



Business Process Changes **THE ROAD AHEAD TO AAN**

ARMY XXI

ARMY AFTER NEXT

Business Process Joint National Reengineering **Maint Mgr** National Manager for Maintenance Seamless Real-Time Financial System Single Stock Fund interlinked with (Force Sustainment Command) National Single Stock Fund NS! Regional NS S

Contractor Prime Vendor Support

dor Contract Life

Partnering - in Research, in Production, in Facility Use, & on the Battlefield

Seamless Life Cycle Support

Acquisition Reform

Flexible Sourcing - All Commodities

Direct Vendor Delivery

Vendor Held Inventory

Global Virtual Direct Vendor Delivery Anticipatory / Precision Logistics

Distribution Based Logistics

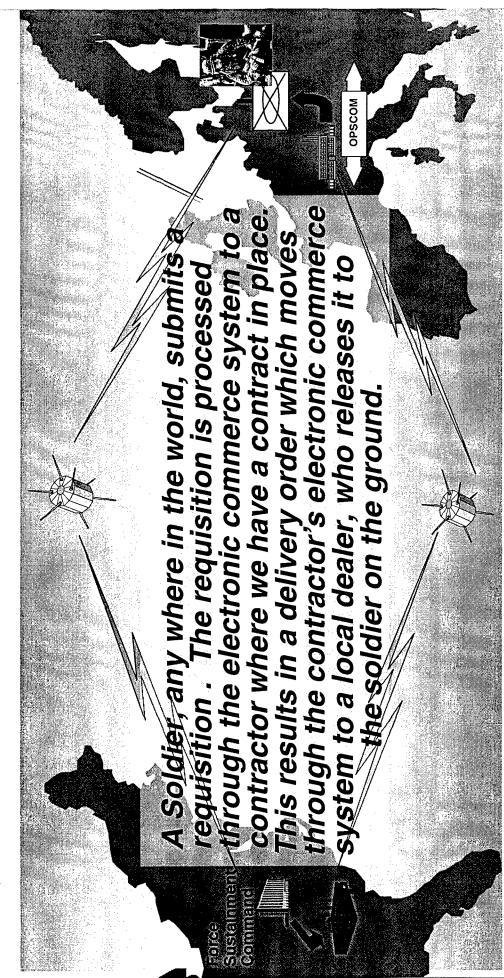
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Velocity Management



SUSTAINMENT VISION



FINANCIAL SYSTEM INTERFACE TO SUPPORT IT DOABLE YES... BUT HAVE TO SOLVE

SUPPORTING SOLDIERS



THE ROAD AHEAD TO AAN - Organizational Changes

ARMY XXI

ARMY AFTER NEXT

Command (LOGCOM) National Logistics **Army Force Sustainment** Command **US AMC**

Theater Support

Command

Elements

Log Spt

Command (OPSCOM) **Operations Support**

Contractors

LOGCAP

Log Pulse

Mixture of

Host Nation Support

CSS Units AOE DIV

Division XXI **CSS Units**

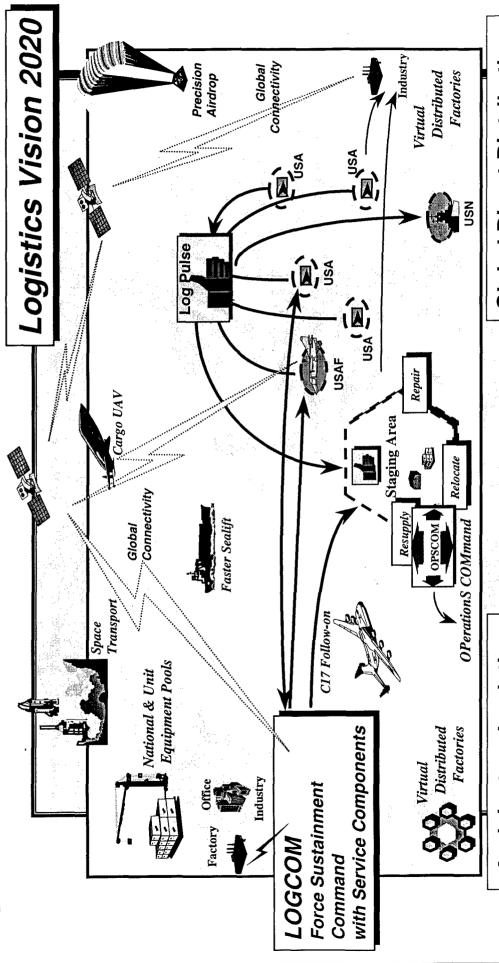
AAN & Div XXI & Units FY09

Active Army

SUPPORTING SOLDIERS



GLOBAL STRATEGIC OPERATIONS



Anticipatory Logistics

Global Direct Distribution

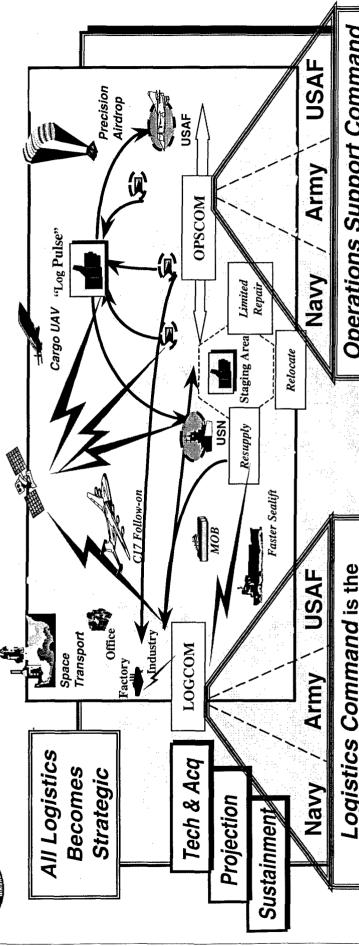
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Like Artillery Fires, Maneuver the "Effects" of Logistics And it's never in Reserve





LOGISTICS ORGANIZATIONS



Connectivity Global Command with Assigned Service **Unified Force Sustainment**

* HQ--Command and Control. Composed of Two Elements: Components:

* Operational -- Service Unique (Ground, Air, Sea) Jointly Staffed

Seamless Logistical System

> An Arranger of Support from Industry and Government to Soldier, Sailor, Airmen

An Integrator of Logistics Domains

Operations Support Command Service Oriented:

Subordinate to LOGCOM in Peace, Cut to CINC, ARFOR, or TF Cmdr when Required

Small Forward Intergrator of all Support. Eyes and Ears of LOGCOM

Mission Rather than Performance. Orchestration and Management Work Done Elsewhere.

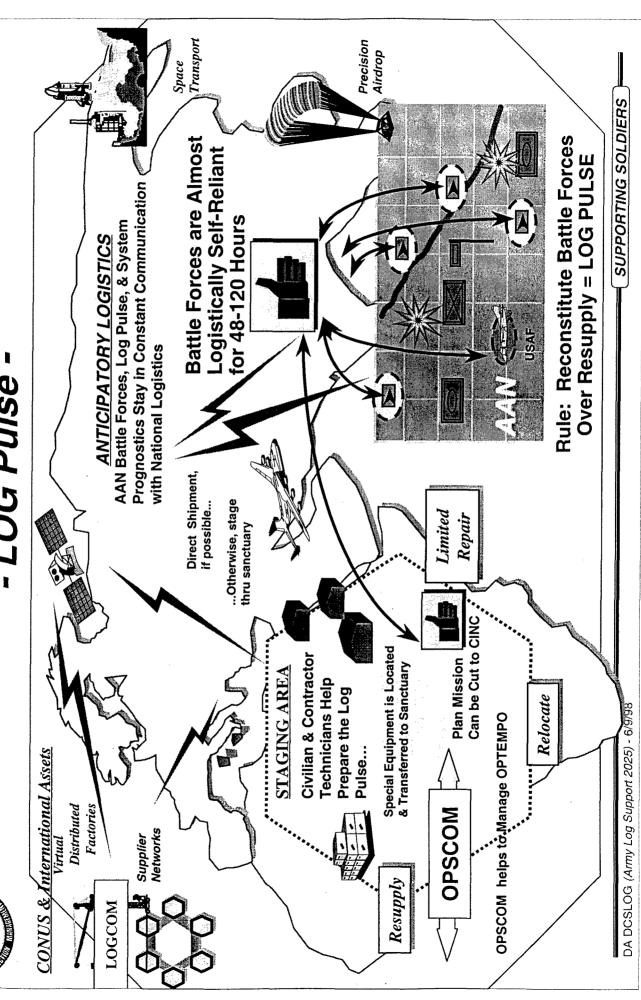
Encumbering Mission Support -ocated Forward Without

Nos



COMBAT & LOGISTICS INTEGRATION





See



THE ROAD AHEAD TO AAN - Systems Changes

ARMY XXI

ARMY AFTER NEXT

User or Supplier with connectivity Transparent to to coalition partnering & Integrated Finandral জ্যুজন্ম Linked to Single Stock Forto Al Enhanced, SembAutionনিয়া - Part of the <u>W</u>arfignes <u>িটে</u> NEESAS & INFORMA SINGLE System- Army (GCSS-A) **Global Combat Support** TC AIMS II CSSCS TC A

GLOB

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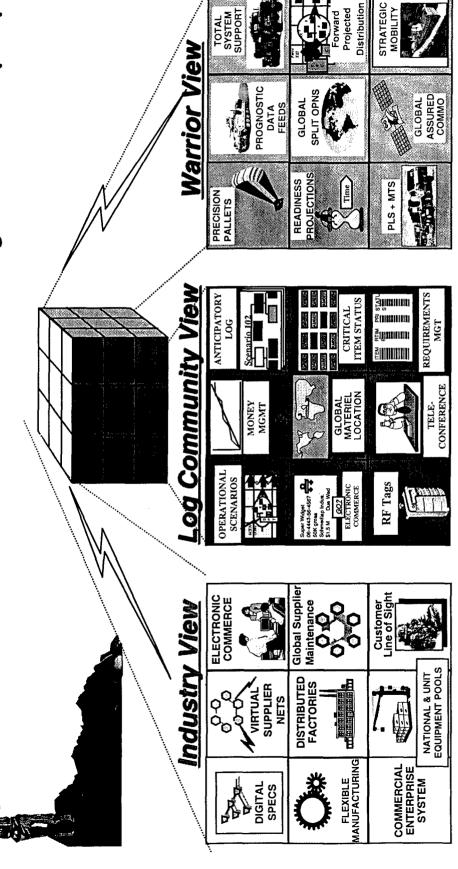
- SUPPORTING SOLDIERS

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SINGLE LOGISTICS SYSTEM & INFORMATION TECHNOLOGY

ONE SEAMLESS LOG and INFO SYSTEM... regardless of the perspective.



Integrated Readiness Management, Log Intervention, Coordination, Distribution, & Financial Control

DA DCSLOG (Army Log Support 2025) - 6/9/98

S08



THE ROAD AHEAD TO AAN - Hardware Enablers -

ARMY XXI

ARMY AFTER NEXT

> Global Comm Tie-in ➤ Built-in Prognostics/Sensors ➤ Linked to Global JTAV ➤ Continuous Operations ▼ Enhanced Cross Country ▼ Extended Range ➤ Fuel/Power Efficient ➤ Stand-off Weaponry ► Linked to Log/Info Network ► Multiple Crews. **COMMON CHASSIS tailorable to support** ➤ Self-Healing, Self-Lubricating ➤ POS NAV ➤ Protection from WMD / Non-Lethal WMD ▶ Fast... Stays with AAN ▶ Air-Deployable multi-purpose missions/functions: **Prognostics Movement Tracking System** > PLS-Enhanced FRS-H IETM IETM BIT / BITE **FMTV** PLS ETM

GPS Assisted Supply UAVs

Precision Air/Ground Robotic Pallets

CROP

Interrogators, 2D Bar Codes)

AIT (RF Tags, AMS Cards,

Strategic Configured Loads

Robotic Maintenance, Recovery, EOD Systems



Tele - Maintenance, Medicine, Personal Statistics

Telemedicine

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STRATEGIC RESEARCH AREAS LOGISTICS TECHNOLOGY

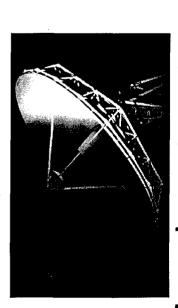
Biomimetics - Novel synthetic materials, processes, sensors that mimic design principles found in nature.



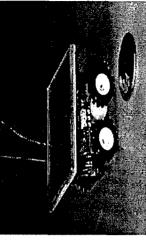
Smart Structures - Complex, multi-element, deformable structures used in land, séa, aerospace vehicles and systems.



hostile environments until completing assigned missions/functions. analyže, learn, adapt, and function effectively in changing, Intelligent Systems - Advanced systems able to sense,



advances enabling rapid, secure transmission of large quantities of multimedia info from point to point, broadcast and multicast over distributed networks for Mobile Wireless Communications - Fundamenta heterogeneous C3I systems.



and performance of structures, materials, devices that have controllable features on the nanometer scale--tens Nanoscience - Innovative, enhancements in properties of angstroms or assembleable atom by atom. Compact Power Sources - Significant improvements in density, operating temperature, reliability, and safety of power.



AAN TECHNOLOGY EMPHASIS

AUTOMATION / COMMUNICATIONS

(Seamless System, Real Time, Complete, Untethered)
Broad Band Commo - - Mobile, Wireless
Al, Sentinels, Intelligent (Neural)
Networks, Natural Language

MOBILITY / DISTRIBUTION

(Power Projection Speed)

Composites, Biomimetics,

Nanotechnology (Lighter
platforms), Embedded Sensors,
All-Knowing "Infobots", Precision
Air Delivery, GPS Assisted
Air/ Ground UAV / UGV (Robotics)

SYSTEM SUSTAINMENT

(Self Reporting, Continuous Status,
Reduced Consumption)
Ultra-reliability, Physics of Failure,
Prognostics via Embedded Sensors
(Predictive Capabilities)
Smart Structures, Biomimetics,
Nanoscience (Self-Repair, Self-Lubricating)
Telemaintenance; Design for Discard

POWER & FUEL/ENERGY SOURCES

(Systems & Soldiers - Reduce Volume, Biggest Class of Supply on Battlefield)
Hybrid Fuel Cells, Advanced Propulsion Systems, Other Fuels (Hydrogen, Nitrogen, Nuclear),
Microturbines

AMMUNITION

Increase Efficiency

Logistics Demand

Reduce

Lowers Logistics Requirements)
Smarter Ammo, Insensitive
Munitions, Embedded Condition
Sensors, Composites ("Smart"
Lightweight Packaging)
Energetic Materials

SOLDIER SUSTAINMENT

(Agile, Individual "Combat Centers")
Composites, Multi-Spectral Protective & "Smart" Fabrics, Mission
Tailorable / Sensory Enhancing
Rations, Physiological & Mental
Health Sensors

- SUPPORTING SOLDIERS

DA DCSLOG (Army Log Support 2025) - 6/9/98



WHAT I WOULD LEAVE YOU WITH

- Our ability to Project & Sustain Combat Power is what will keep us relevant as a Nation . . . and an ARMY
- We will continue to exploit Technology . . . And the capabilities of the Information Age
- Logistics becomes a greater Force Multiplier in the 21st Century Army
- Implementing & Sustaining the RIML are keys to Army XXI & AAN



"A Revolution in Military Logistics,
Leveraging Technology to Fuse
New Concepts, Information, and
Logistics Systems, Reshaping the
Way We Project and Sustain
America's Army in the 21st Century"

Distribution Based...
Seamlessly Connected...

Important Web Sites for More information on the Revolution

www.hqda.army.mil/logweb http//lia.army.mil amc.citi.net/index.shtml www.cascom.army.mil

- SUPPORTING SOLDIERS

with Agile Acquisition.



2025 FOCUS WILL STILL BE



- SUPPORTING SOLDIERS





INDUSTRY PROJECTIONS FOR FOR FORCE XXI/AAN OR WILL WE STILL BE THERE?

Presented By:
Stephen L. Gurba
President & CEO
Bulova Technologies L.L.C.

Armaments for the Army of the Future 23 - 24 June, 1998

FORCE XXI

- ▲ Evolve a new force
- Ammunition still required

IAAN

- △ A new fighting force
- ▲ Faster, lighter, more lethal
- △ "Legacy" or current force still a factor
- △ Ammunition still required

□ Background

Status of XXI/AAN

Status of Ammo Base

| Future of Base

→ Bulova Example

∠ Conclusions

| Recommendations



STATUS

- Battle Labs
- Digitized Force Tests
- ▲ Technology Needs Being Identified
- Example Fuze Technologies Needed
 - + Advanced Sensors
 - + GPS Fuze
- + Microminiturization
- △ Major Priority Programs Underway
 - Crusader
- Commanche
- Digitization
- ∠However, Status of Ammo Base still Remains Critically in Danger due to low or no Budgets for Acquisition of Hardware



AMMO BASE STATUS

- Base Continues to Downsize Companies going Commercial
- Procurement for Production is low or eliminated
- JR&D Funding Minimal
- ☐ Army 2000 POM to Sacrifice R&D/Procurement for Troop Support
- Longress support Ammo but has limited flexibility under budget cap
- Unrestricted Globalization a Risk



FUTURE OF BASE

 △ As programs go overseas, companies leave what's left of the base Without a base, there is no R&D and there is no capability for production

☐ Many companies tending toward commercial operations, sale/merger, or going out of business



BULOVA EXAMPLE

∠ Major Fuze Producer for U. S. Army

J Downsizing of Bulova Military Capabilities

▲ DOD buying minimal quantities of fuzes

▲ Loss of Skilled Workforce (very difficult to replace)

△ Dismantle Volume Production Capability (all company-owned)

☐ Bulova Involvement in Commercial

 \triangle 50% of sales 1998, zero in 1994, 80% in 1999

▲ Electromechanical devices and assemblies for commercial products

▲ Becoming a major outsource supplier

☐ If needed for Mobilization - Major Time/Effort needed to retrain, re-establish lines and produce fuzes

THE PERSON NAMED IN COLUMN TO PERSON NAMED I

 △ Although information technology advances will make Force XX1 and AAN happen -

unique munitions (fuze is an example), technology will Loss of munition base capability and critical skills for disappear JAAN might not have the ability to kill the enemy whose position it has pinpointed

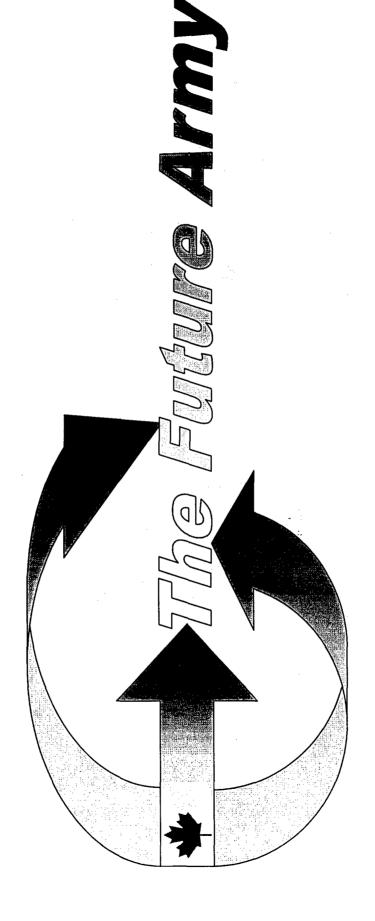


RECOMMENDATION

Implement actions to preserve base so developments can proceed with funding and industry will be there for AAN.

- ▲ Review and implement details of Battelle Industrial Base Study
- ▲ Identify critical skills and technologies
- △ Program funds to procure quantities to "keep the doors open"
- ▲ Obtain authorization to procure w/o competition
- ▲ Multi-year contracting expanded
- ▲ Control overseas procurement in critical munition areas
- ▲ Globalization in ammo procurement should not be generalized policy - ammo is different
- △ DOD has made defense a business, we must return to keeping the soldier and our nation's defense the number 1 priority

CANADA'S EFFORTS TO DETERMINE



National Défense Defence nationale

PRESENTATION

First provide background to current Canadian Land Forces

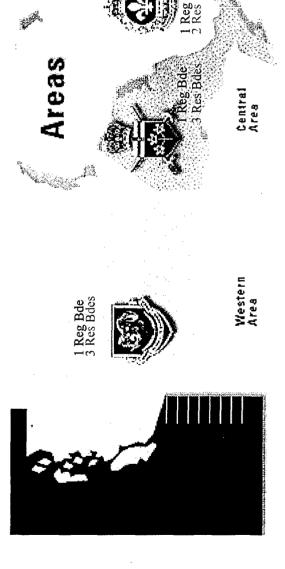
develop the structural, doctrinal, training **≯Outline the processes being used to** and equipment requirements of the Canadian Army in the 21st Century



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LAND FORCE STRUCTURE



1 Reg Bn Gp 2 Res Bdes

Atlantic Area

	Recular	Recente Civilian	Civilian	
	Iscyalai		Civiliali	
Land Force Command HQ	283	7.1	26	
Land Force Western Area	5,864	3,902	1,621	
Land Force Central Area	4,642	5,410	1,039	·
Land Force Quebec Area	3,389	3,439	834	
TOTALS 46,538	19,778	17,017	5,134	
				1



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CURRENT OPERATIONAL COMMITMENTS

➤ 12 UN Operations

➤ 3 NATO Operations

➤ 1 MFO Operation

➤ 1 Disaster Relief Operation

National Defence

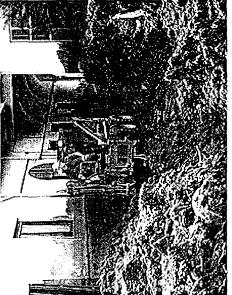
Défense nationale

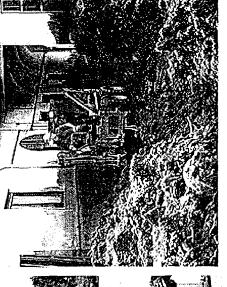
CURRENT OPERATIONAL COMMITMENTS

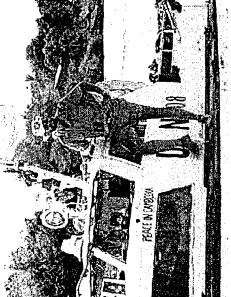
















Défense nationale National Defence

CURRENT VEHICLES/MAJOR EQUIPMENTS



Leopard Tamk



M109 Medium Self-propelled Howitzer



Antitank System Air Defense



M113A1 Armoured





Personel Carrier









LAV-Recce

Armoured Vehicle General Purpose

Bison





litis Canadian Light Utility Track

Light Support Vehicle Wheeled (LSVW)

Medium Logistic Vehicle Wheeled (MLVW)

Heavy Logistic Vehicle Wheeled



TOW Under Armour



Hercules CC-130





Bell CH146 Griffon Helicopter





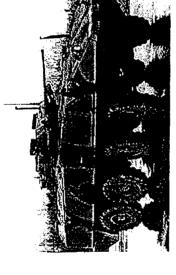
nationale Défense

CURRENT ACQUISITION PROGRAMME

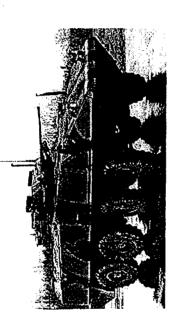
Priorities:

- Soldier Systems
- Information Systems
- · Vehicle Mobility Systems
- Mine Defence Systems
- Firepower Systems Training Systems

- Major Projects:
- ◆Clothe The Soldier
- TCCS
- IPCE
- •ACV
- ◆APC Replacement





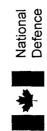




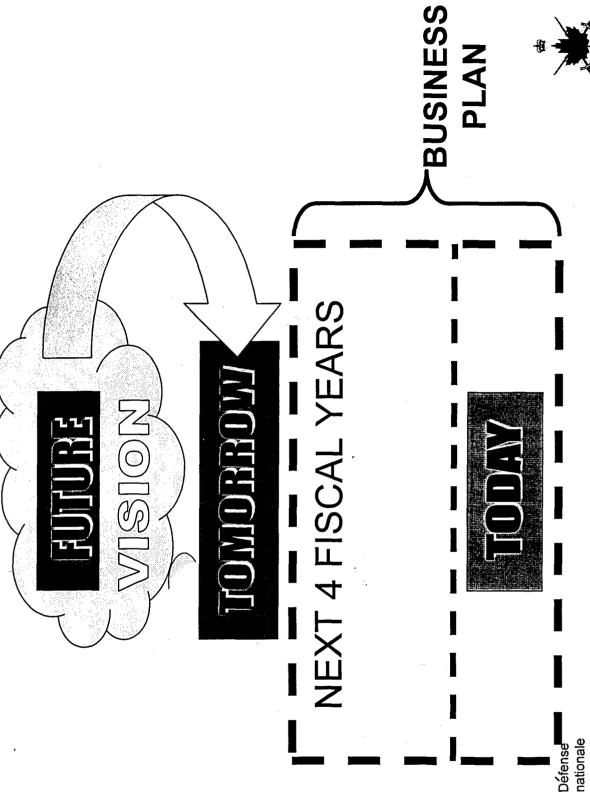


DEVELOPMENT PROCESSES PREVIOUS LAND FORCE *UNSOITABLE*

- ➤ DESIGNED FOR EVOLUTIONARY CHANGE
- > CATERED TO ALL ARMY INTEREST GROUPS
- ► LITTLE CONCEPTUAL THINKING
- **▼ NO RESOURCE CONSTRAINTS**
- > INPUT LARGELY FROM WITHIN ARMY

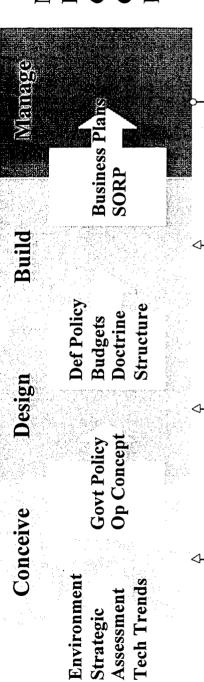


THE THREE ARMIES



National Defence

LAND FORCE DEVELOPMENT PROCESS



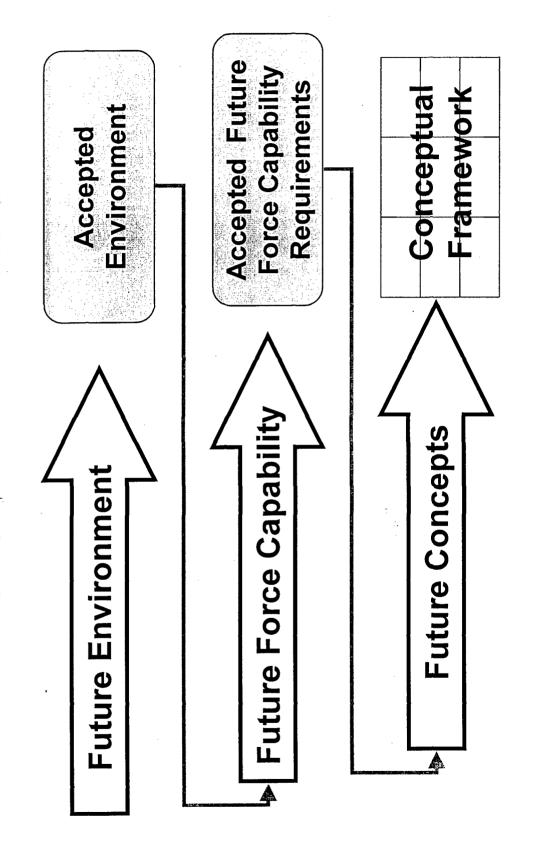
Multi Purpose Combat Capable Forces

Performance Measurement

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THE FUTURE ARMY PROCESS

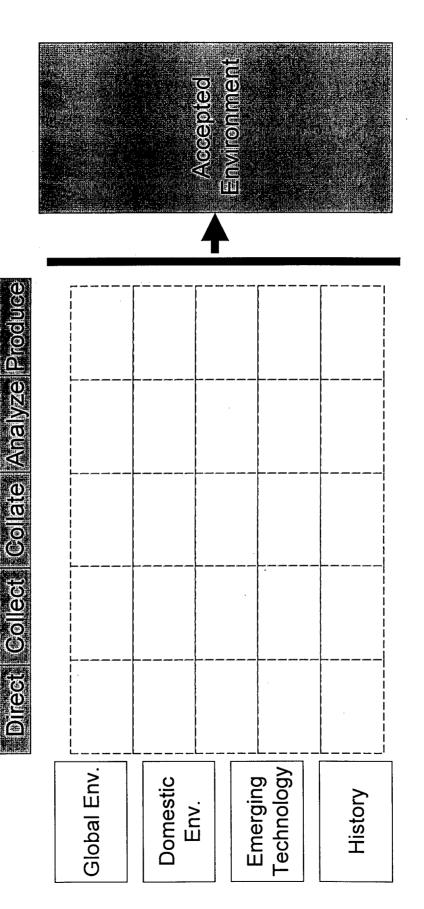


Futures Team

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DETERMINING THE FUTURE ENVIRONMENT



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FUTURE GLOBAL OUTLOOK



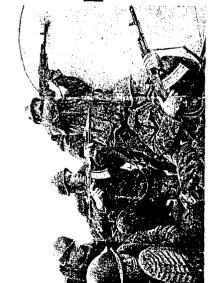
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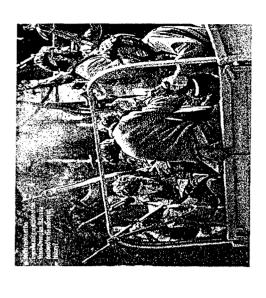
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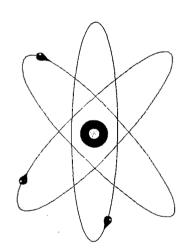
POST COLD WAR ENVIRONMENT



ETHNIC CONFLICT **REGIONAL AND**



NEW WARRIOR CLASS



NUCLEAR THREAT



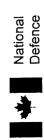


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FUTURE GLOBAL OUTLOOK

- > Ethnic, Religious and Nationalist Rivalries
- > Emergence of New Warrior Class
- > Economic and Ecological Pressures
- > Proliferation of High Tech Weapons
- Global Economic and Information Dependencies
- > Continued Risk of Major Regional Conflicts
- > Increased Frequency of Non-traditional Forms of Warfare
- > Use of Criminal & Terrorist Acts by State and Non-state Bodies



Vational Défense Defence nationale





TRENDS IN FORCE DEVELOPMENT

> Forces Capable of Warfighting in Major Regional Conflicts

> Forces Capable of Conducting Specialized Operations



CHANGING CHARACTER OF WAR

1995

- linear, defensive ops ✓ Forces prep to fight
- Strong allied commitment
- Fighting with legacy systems
- Thick logistical LOCs
- / Attrition of attacking forces

- ✓ Nonlinear, simultaneous sdo
- Challenged to maintain strong coalition
- ✓ Complementary joint forces
- ✓ Precision ops, info dominance
- ✓ Rapid decisive ops to disintegrate enemy





DOMESTIC CONSIDERATIONS



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DOMESTIC CONSIDERATIONS

➤ Fiscal Reality

> Shifting Demographics

➤ Decline of Deference

➤ Appeal of Peacekeeping

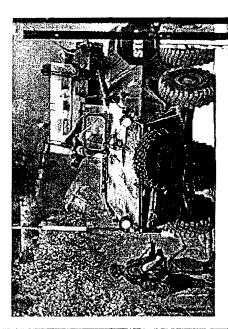
National Defence

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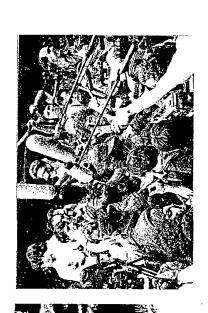
DOMESTIC CONSIDERATIONS







Appeal of Peacekeeping



Internal Security

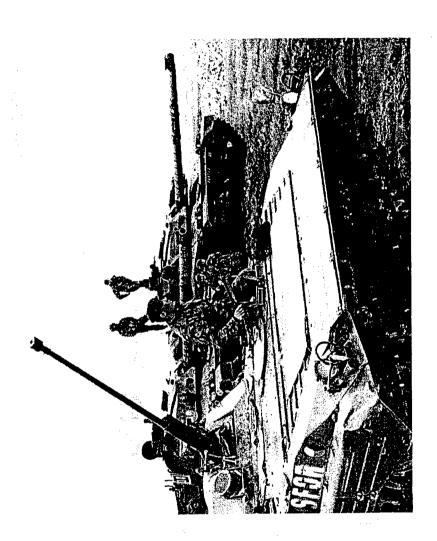


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ALLIANCE AND COALITION WARFARE



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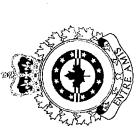


ALLIED FORCE DEVELOPMENT



Organisation du Traité de l'Atlantique Nord North Atlantic Treaty Organisation







>Conform to Allied Operating Procedures

>Monitor what Allies are doing



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ALLIED FORCE DEVELOPMENT

>NATO Land Operations (LO) 2020

➤ U.S. Army After Next (AAN)

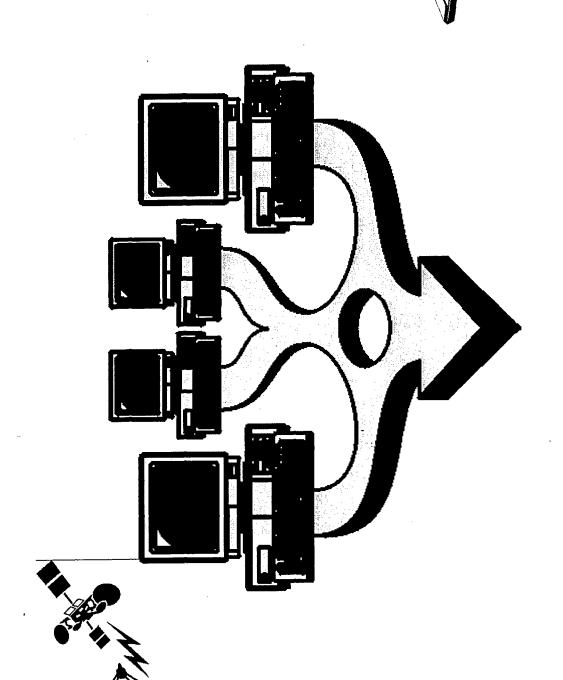
> British Army 2000 (BA 2000)

≯ Australian Army 21 (A21)

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EMERGING TECHNOLOGIES



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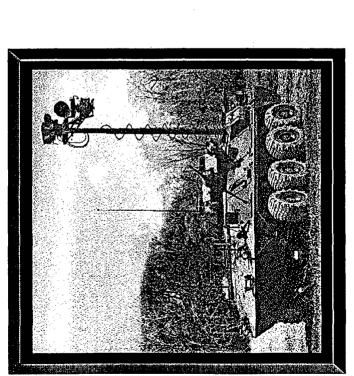
EMERGING TECHNOLOGIES

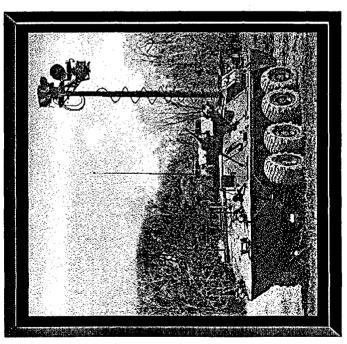
- > Command and Control Automation
- > Situational Awareness
- ➤ Information Operations
 - > Lethality and Accuracy
- **▼**Stealth
- > Soldier Performance
- ➤ Exploitation of Space
- **∀** Robotics
- ➤ Non-lethal Weapons





TECHNOLOGY IN THE CANADIAN ARMY





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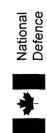
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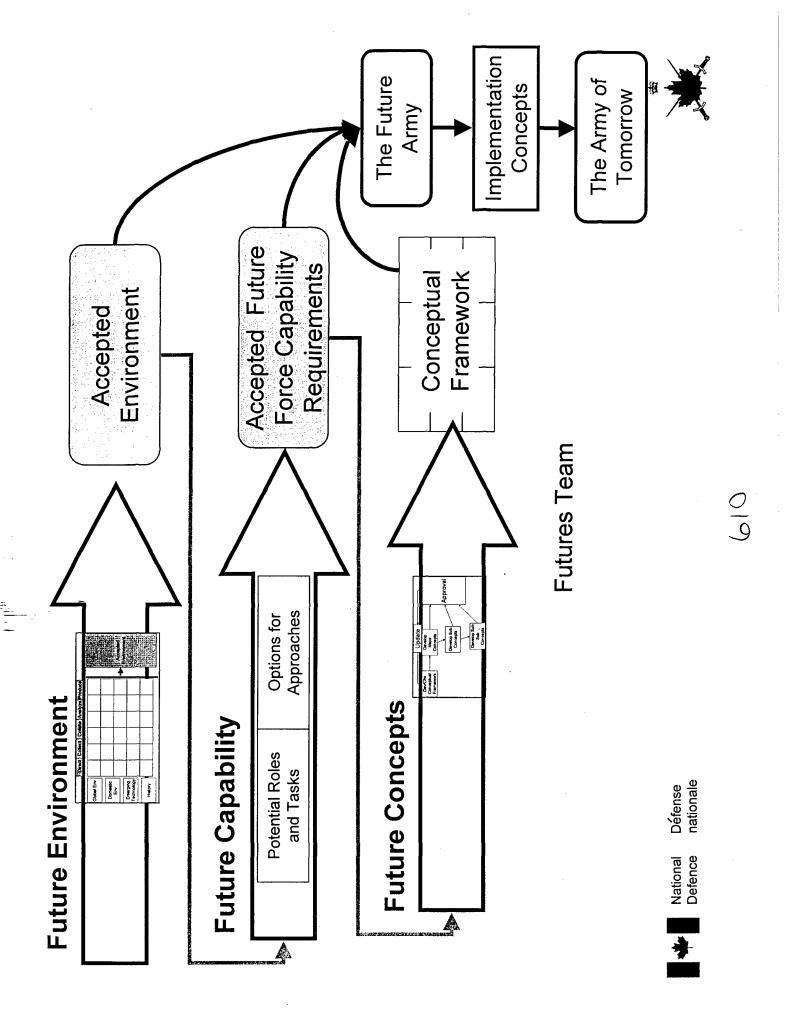


SUMMARY OF ENVIRONMENTAL **FACTORS**

- **► ADVANCE OF TECHNOLOGY**
- > GREATER GLOBAL INSTABILITY
- > EMERGENCE OF INFORMATION AGE
- > RESOURCE CONSTRAINTS
- **◇ GLOBALIZATION/COALITION OPS**
- > EVOLUTION OF MILITARY ART
- **▽ INTERDEPENDENCE**
- > EVOLUTION OF SOCIAL ORDER

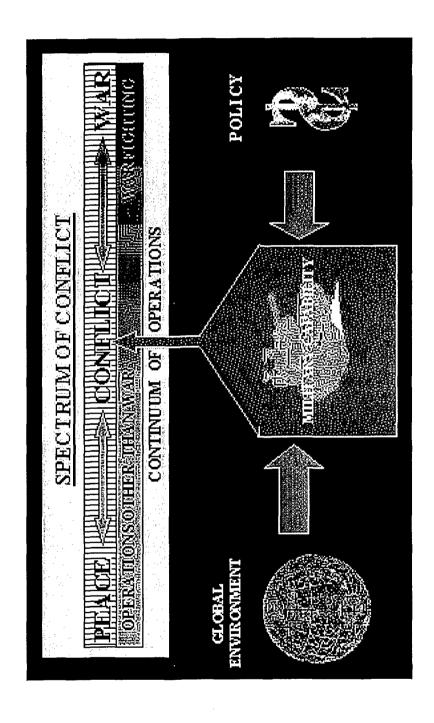


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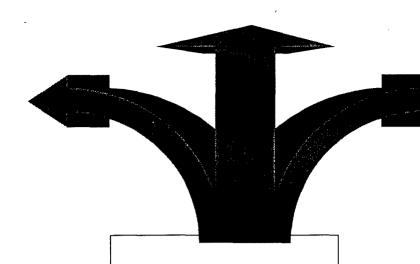


THE CHALLENGE OF DEVELOPING MILITARY CAPABILITY



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DEVELOPING FUTURE FORCE CAPABILITY REQUIREMENTS



Approaches **Options for**

Potential Roles

and Tasks



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DEVELOPING CONCEPTS Approve Update Develop Sub Sub Concepts Develop Sub Concepts Concepts Develop Major Framework Conceptual Develop/ Confirm

6/3

Implement

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Dedide to



FUTURE ARMY STAFF FULL TIME

➤ CONCEPTS - DLSC - 5 OFFICERS

>SCIENCE & TECHNOLOGY -DRDB - 1 SCIENTIST

▶OPERATIONAL RESEARCH-DGOR - 2 SCIENTISTS

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LEADERSHIP OF THE FUTURE **ARMY PROCESS**

> RESPONSIBLE TO - ARMY COUNCIL

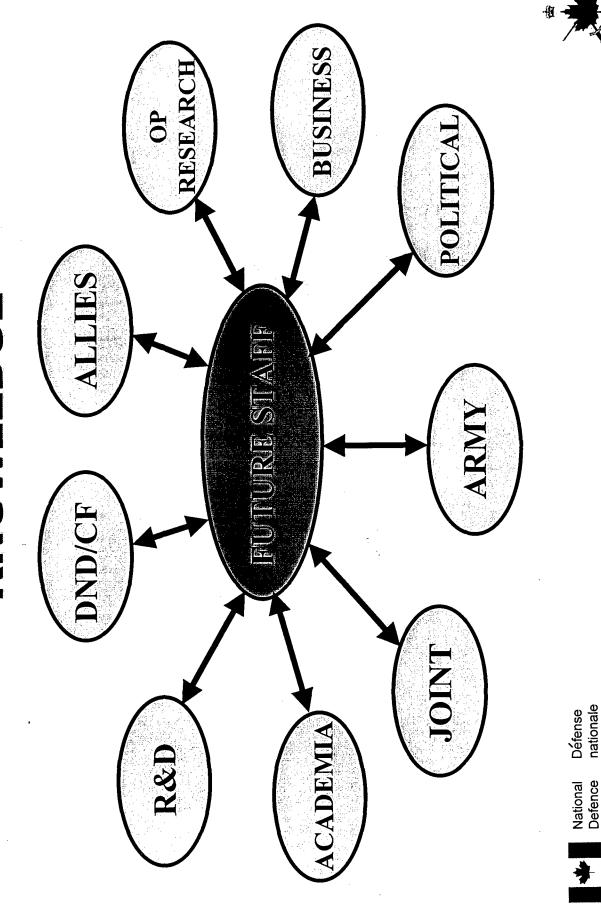
> DIRECTION - COMDT CLFCSC

VINTERIM STEERING GROUP - COMD 1 DIV, SAL, DGOR, COMDT CLFCSC



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THE VIRTUAL CENTRE OF KNOWLEDGE

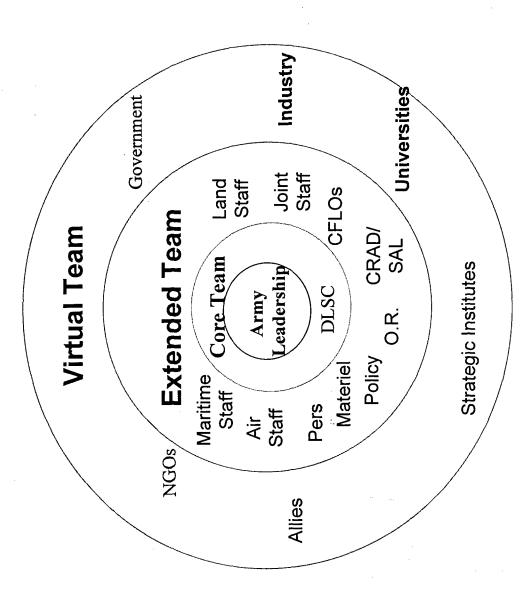


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ORGANIZATION OF FUTURE ARMY TEAM



National Defence

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HARNESSING OF INTELLECT

> SERVING MEMBERS

DEFENCE SCIENTIFIC & OR

> ACADEMIC & BUSINESS

VALLIES

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EXPERIMENTATION

> DEFENCE RESEARCH LABS

TEST & EVALUATION

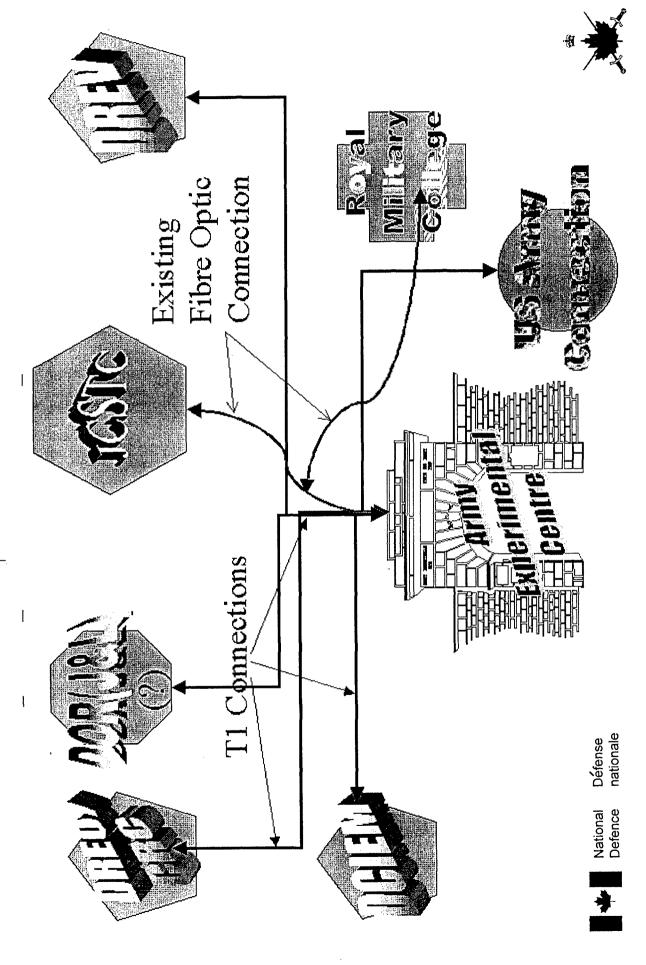
▶OPERATIONAL RESEARCH

> SIMULATION

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THE ARMY EXPERIMENTAL CENTRE



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ARMAMENTS FOR THE ARMY OF THE FUTURE

Symposium and Exhibition

24 June 1998

Chief, Science Technology & Programs Division Directorate of Force Developments, USAARMC Alan Winkenhofer Fort Knox, KY



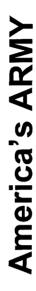




Army After Next

Emerging Operational Concept

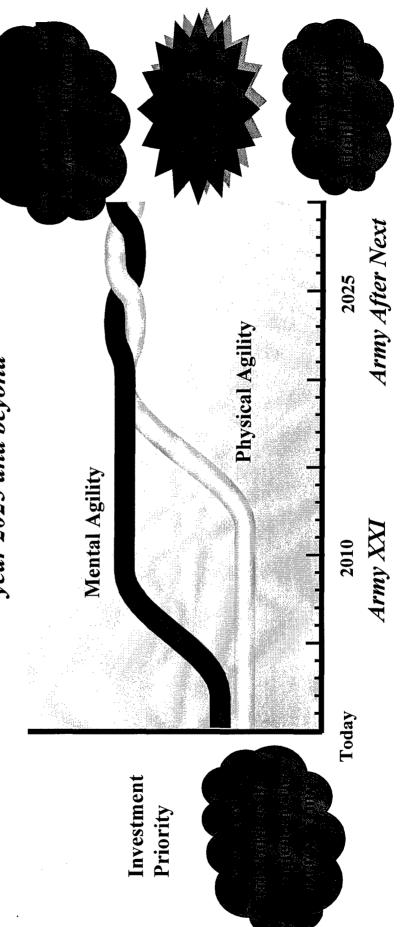
- Precision lethality, precision maneuver
- **■** Information based warfare
- Rapid strategic & operational deployability
- Fast operational & tactical mobility
- Dramatically reduced logistics tail
- countermeasures & stealth vice heavy armor protection Survivability thru situational awareness, mobility,
- Advanced human factors integration
- Ability to leverage new technology







AAN is the process for the development of future warfighting concepts supported by research and technology relevant for the year 2025 and beyond





General

ARMY AFTER NEXT FCS CHARACTERISTICS

- A multi-role, multi-functional ground system that enables revolutionary force effects
- Growth potential integrated into each sub-system and component
- Optimized for lethality, with unprecedented mobility and survivability capability
- Long range information/C2 connectivity to other battlefield functions/delivery

systems

- Air Transportable enhanced strategic, operational, and tactical mobility
- Efficient power sources for all functions (lethality, survivability, mobility)
- Precision weapons, point or area, multipurpose munitions
- Remote capability for mine warfare
- Ultra low signature
- Embedded training, planning, rehearsal capabilities









Lethality

Desired Capabilities

- Both NLOS and LOS capable
- ◆ Precision non-line of sight preferred engagement
- Line of sight for close combat (point& area targets)
- Defeat any threat armored vehicle equipped with advanced ERA & APS
- Multi-purpose munitions (aerial, personnel, bunkers, buildings, etc)
- Long-range target detection & identification
- Near simultaneous engagement of multiple type targets
- All weather capable systems
- Automatically plan, optimize, and execute selected lethality options

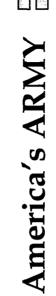






Survivability

- Light-weight armor
- Ultra low signature in all spectra
- Active protection system
- Defeat incoming threat direct and indirect CE & KE munition without reliance on heavy armor
- ▶ Any munitions residual effects limited to medium caliber cannon
- Ballistic protection for crew (2 or 3) that defeats up to medium caliber cannon, air burst, artillery and mines
- Standoff detection of surfaced laid and buried mines; remotely disable/ defeat mines







Strategic/Operational Deployability Operational/Tactical Mobility

- Deployable by C130-like airframe
- Conduct continuous operations without CL III resupply: 2 days/

800 - 1500 km

- 90 km/h cross country dash speed
- 75 km/h sustained cross country speed
- 120 km/h sustained road speed
- Automatic navigation and movement

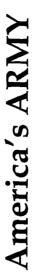




Sustainment

- Up to 30 days or 1500 kms of operation before power resupply
- 7-10 days before ammunition resupply
- Redundancy, with automatic re-allocation of tasks if components malfunction
- Fault/failure free platform components ultra durability
- Ease of maintenance; repairable by crew, automatic prognostics to anticipate failures before they occur and automatic diagnostics that pinpoint failures
- Embedded, automatic fuel, ammo, maintenance status reporting
- All mobility-restoration or maintenance tasks require no more than

two personnel







MANPRINT

- 2-3 man crew
- Sensor, artificial intelligence, and other technologies optimized to reduce task loading on crew
- ▶ Improve quality of decisions and accelerate human execution
- Ability to move people/equipment in all configurations
- System design and operation minimize repetitive training necessary to maintain a high proficiency standard
- User friendly controls
- Design enables extended continuous manning by crew
- Fully embedded training and rehearsal system







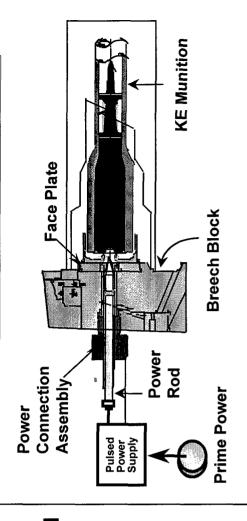
Electro-Thermal Chemical Gun

Potential Pay-Off

- ■140mm performance with growth potential
- ■Can fire smart munitions + conventional rounds
- Improved accuracy
- ■Potential for marginal hypervelocity performance
- ■Potential for low vulnerability propellant

Development Issues

■Development of a high energy benign propellant



ETC Power Connection & Breech Configuration

Assessment

- No revolutionary lethality
- ■No reduced ammunition logistical burden
- ■Avoids the burden of a conventional 140mm upgrade
- Most suitable as a risk mitigator to sustain Abrams overmatch





Electro-Magnetic Gun

EM Tank Concept

Potential Pay-Off

- Overmatch lethality through hypervelocity:
 - Tunable muzzle energy lethality at ordnance velocity
 - ■Low visual signature
- Pulsed power available for other applications (DEW)
 - Synergy of "all electric" vehicle
 - Reduction in ammo logistics

Development Issues

- Pulse power volume/weight
- Utility of hypervelocity against advanced armors
- Launcher and projectile challenges
- ■High density prime power source (not included in this program)
- ■Impact on crew and system

Assessment

- ■Potential for revolutionary effects; overmatch with elimination of ammo log tail
- Significant developmental challenges to weaponize
- ■Pulsed power storage efforts may be most significant contribution





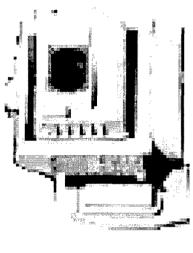
Directed Energy Weapons

Potential Pay-Off

- Lethality alternatives from incapacitation to "Soft kill"
- Multi role / function uses
- Reduction in logistics burden
- Facilitates all electric vehicle & associated potential advantages
- Significant opportunities for survivability enhancements

Development Issues

- Power storage size & weight
- Effect at tactically desirable ranges; ability to localize effects
- Sensitivity to movement
- Antennas, power conditioners, beam propagation, etc
- Political sensitivity



Particle beam

High power

■ Lasers

microwave

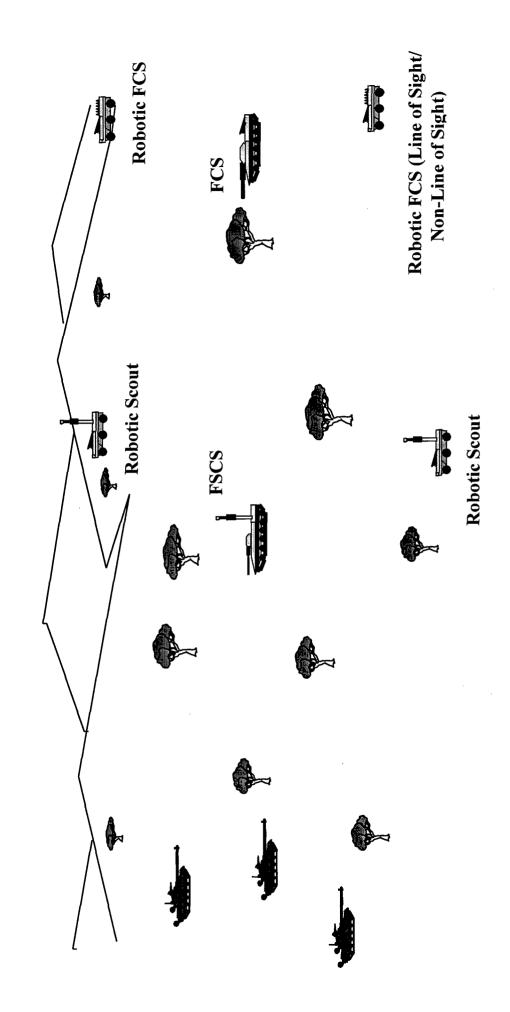
Stingray (as an early example)

Assessment

- Revolutionary defeat mechanism
- Near to mid-term as a secondary weapon-medium risk
- Potential for primary weapon-high risk
- Considerable DOD \$; no \$ focused on ground platform program



AAN Design Systems



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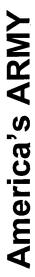
Future Combat Vehicle

Combat Developer Conclusions

- No evidence that by 2003-2005 a single technology will be sufficiently viable to provide "Leap Ahead" lethality for fielding before 2015-2020
- Evidence suggests that by 2003-2005 a combination of technologies will prove viable, that when synergistically packaged have the potential to provide "Leap Ahead" warfighting effects
- Key enabling technologies
- Directed energy
- ◆ Active protection (CE&KE)
- with standoff defeat
- ♦ All electric systems
- Hybrid electric drive
- Fuel Cells
- Pulsed power storage

♦ Signature management

- ♦ High density engines
- Lightweight materials for structure/protection











Future Combat System



NDIA/ARDEC Firepower Symposium

24 June 1998

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Tank-automotive & Armaments COMmand

96/16/98

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- FCV Lethality/Survivability
 - Development Schedule
- Operational GoalsTechnology Opportunities
 - System Integration
- Summary & Conclusions





System Effectiveness Study





FCS Operational Goals



-Lethality

Defeat all known & projected Threats (3-5 km LOS & 10 km NLOS)

Survivability

without heavy armor (Only medium caliber ballistic protection) Defeat direct fire CE & KE munitions and top attack weapons

Mobility

100 kph CC burst speed (70 kph sustained)

Fightability

Reduced crew operation/Situational Awareness

Deployability

(1) FCS per AAN Advanced Air Transport

Sustainability

50-75% reduction in Class III, V IX over 30 day mission

(Self sufficient for 48 hours)

A multi-role close combat system



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Electro-Thermal Chemical Gu

Potential Pay-Off

140mm performance with growth potential

Can fire smart munitions + conventional rounds

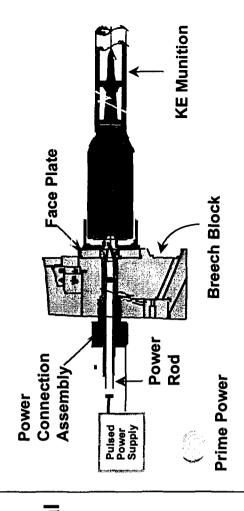
Improved accuracy

Potential for marginal hypervelocity performance

Potential for low vulnerability propellant

Development Issues

Development of a high energy benign propellant



ETC Power Connection & Breech Configuration

Assessment

No revolutionary lethality

No reduced ammunition logistical burden

Avoids the burden of a conventional 140mm upgrade

Most suitable as a risk mitigator to sustain Abrams overmatch

F9



Electro-Magnetic Gun



Potential Pay-Off

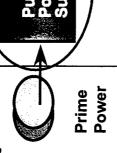
Overmatch lethality through both hypervelocity and ordnance velocity; ERA & KE APS defeat

Tuneable muzzle energy - lethality at ordnance velocity

Pulsed power available for other applications (DEW)

Possible reduction in ammo logistics

Synergy of "all electric" vehicle



Assessment

Conducting Rails

Projectile

Armature

Potential for revolutionary effects; overmatch with elimination of ammo log

Significant developmental challenges to weaponize

Pulsed power storage efforts may be most significant contribution

Development Issues Pulse power volume/weight

Utility of hypervelocity against advanced armors

Launcher and projectile challenges High density prime power source (not

Impact on crew and system

included in this program)







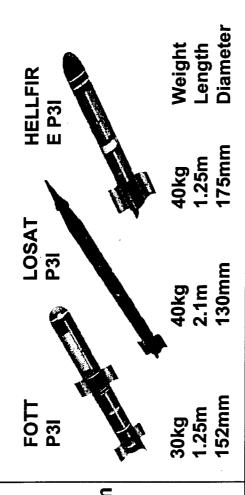
Potential Pay-Off

- Lethality overmatch
- **◆LOSAT** delivers >15 MJ on target at 4km
- Precision kill > 10km
- Inherent growth potential with minimal changes imposed on system

Development Issues

- Reduction in length while maintaining **lethality**
- Counter measures
- On board survivability
- Fire on the move

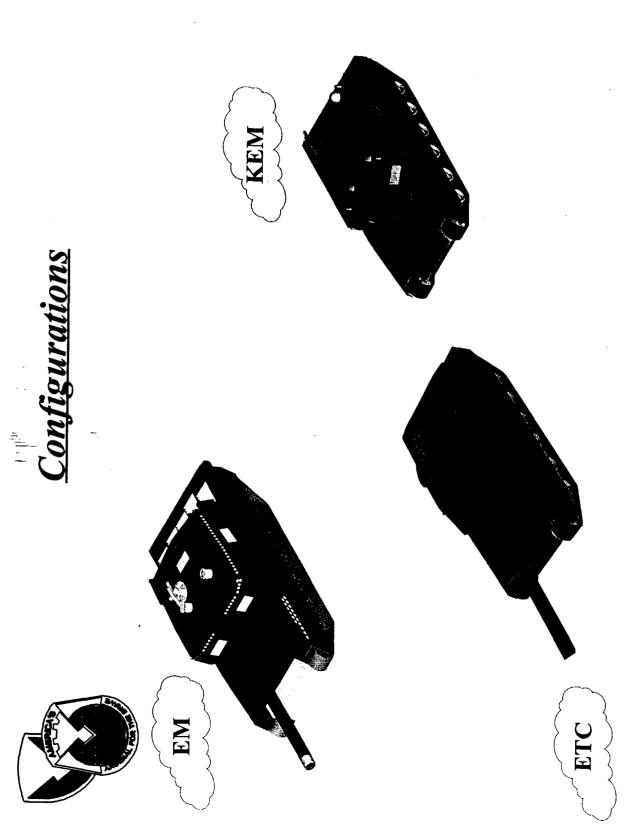
Missile Technology



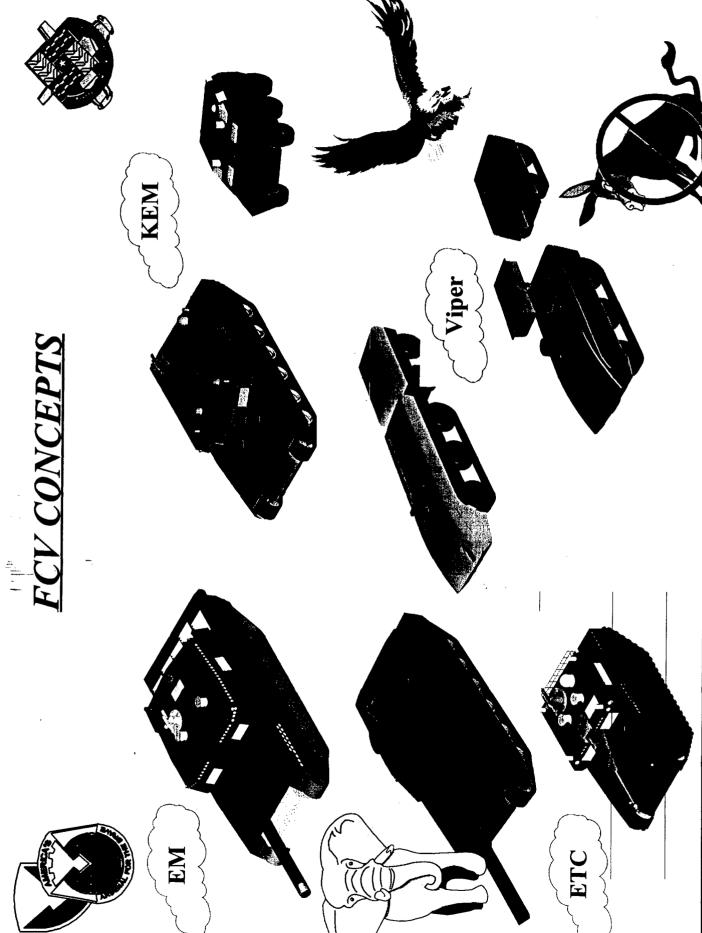
Assessment

- Overwhelming defeat mechanism
- ■Logistical burden
- ■Potential mid term bridge if
- ◆Reduced in size and weight
- **◆Used with another weapon**















SUMMARY

ONE KILL PER SHOT AT EXTENDED RANGE AND OVERWHELMING LETHALITY REQUIRES SMART MUNITIONS

FCV/AAN SYSTEMS NEED MULTIROLE TECHNOLOGY-DIRECT AND INDIRECT (NOT NECESSARILY ON ONE PLATFORM)

MODULAR APPROACHES AND CREATIVE PACKAGING FORCE PROJECTION AND SUSTAINMENT DEMANDS

The UK Electric Gun Programme in 1998

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Abstract - The UK is undertaking research into both electromagnetic (EM) and electrothermal-chemical (ETC) propulsion for future weapon systems. In the EM field, efforts have been concentrated in the railgun armature area. Recent work has tried to reduce the parasitic mass of base-push solid armatures, since this leads directly to lower launch energies and greater overall system efficiency. The aim is to understand the many property requirements needed to allow velocities over 2000 ms⁻¹ with full mass payloads. The use of multi-material armatures has been shown to be beneficial both theoretically and through examination of hardware recovered after firings at Kirkcudbright. Conditions at high velocities and energies have been found to be vastly different from those at more moderate levels, and support the UK decision to tackle the problems in these difficult regimes.

Recent ETC research effort has spanned the topic from the fundamental to the systems' levels. The fundamental plasma-propellant interactions continue to be studied. Enhanced gas generation rates (EGGR), both during and in some cases after the electrical discharge, have been studied in a wider variety of propellant types and geometries. The scaling of plasma generators has been investigated. A plasma jet type of plasma generator has been operated successfully in open-air at a peak electrical power of 3 GW. The concept of muzzle velocity control of artillery guns known as "Smart Gun" has also been studied. Analysis indicates that the concept has the potential to significantly improve artillery precision.

I. INTRODUCTION

The last major published review of the UK electric gun programme was presented at the 8th EML Symposium in 1996 [1]. Since that date, a significant amount of work has been carried out, resulting in a much greater knowledge of the fundamentals of this new technology. The focus for the work remains the same as before, i.e. electromagnetic (EM) launch for high velocity direct fire applications (tanks) and electrothermal-chemical (ETC) propulsion to increase the performance of large calibre artillery systems. Both programmes are well established and enjoy good MOD customer support.

If EM guns are to achieve more than just paper promise, they will need to demonstrate improvements in direct fire attack of armour targets. The EM launcher work has an agreed set of criteria that the technology should meet by the end of the century. These criteria cover a number of aspects relating to the use of this method of propulsion for high velocity direct fire attack of armour targets.

The ETC work is being conducted jointly with Royal Ordnance (RO). DERA is responsible for most of the theoretical, chemical and electrical underpinning work, whilst RO perform medium calibre (30/45 mm) gun firings. This work is moving rapidly towards large calibre 155 mm trials of ETC artillery concepts.

II. ELECTROMAGNETIC LAUNCHERS

In 1996, very little armature design work had been undertaken in the UK. A baseline 90 mm armature had been used for virtually all the firings up to then. This had been successfully fired at Kirkcudbright at typical ordnance velocities (1500-1700 ms⁻¹) with conventional aluminium alloy saboted long rod penetrators, and at higher velocities at the Green Farm test site in the US. However, the armature weighed approximately 1.2 kg, and represented a significant proportion of the whole launch mass of 3.5 kg. As the velocity had to be raised beyond 2000 ms⁻¹, there was obviously some development effort needed in this area. The goals of increasing the velocity, imposing greater thermal, mechanical and electrical loads on the armature, whilst trying to reduce its mass, were challenging to the UK team.

Before this work started, however, an accuracy trial was fired from the 90 mm IAP laminated gun. A dozen rounds were fired at the 1000 m range target. Limitations imposed by the gun meant that the shots had to be fired at around 1550 ms⁻¹. Additionally, the movement of the bore gave problems in using the conventional gun boresight, used to lay the gun onto the target. An interface tube was designed to reduce the effects of the non-circularity of the gun near the muzzle, and a consistent aiming method developed to further reduce errors. As a result, the apparent consistency of the gun improved with time, even though the bore condition was deteriorating. No inter-shot honing was possible then.

The results demonstrated that EM guns could achieve satisfactory accuracy and consistency. Earlier fears that such guns could suffer from an anomalous electrical effect which caused them to shoot wildly were clearly disproved. Despite the fact that the experimental gun was far from ideal, the results were clear enough to ease the minds of any doubters.

Once this trial was completed, the gun became available for armature experiments. It was deemed unsuitable for firing more advanced projectiles because of the bore irregularities and dilation under firing loads. Projectile firings at higher energies and velocities were postponed, pending further strengthening of the IAP gun, or availability of a stronger stiffer barrel.

Efforts to reduce the parasitic mass of solid armatures included both design and materials options. Earlier trials at 40 mm [1] showed that no one alloy had the range of mechanical and electrical properties required in a monobloc armature. The balance of properties depends strongly upon the exact duty cycle of the armature, and varies with payload, calibre and velocity, to name but a few. At this point in the programme, a total launch mass of 3 kg was chosen for future 90 mm armature designs. Power supply limitations were dominant in deciding this value.

Two ultra-lightweight armature designs were shot. These had approximately one and two thirds the leg length of the baseline design. Both transitioned early in the launch cycle, due to their reduced capability to handle the applied electrical action, and significant amounts of plasma were ejected from the breech of the gun. Additionally, the shorter version was observed to be highly unstable in-bore, due to its poor I/d ratio, Fig.1. It was obvious that there was to be no dramatic mass reduction, and that design changes would have to be evolved.

Over the course of a year or so, nineteen 90 mm armatures were fired, and over 75% were physically recovered by careful searching of the ground in front of the gun. These recovered pieces were closely examined and, in conjunction with the normal electrical and X-ray data recorded, allowed selective changes to be made to various parts within the armature body. Some mass was removed from the base of the armature, until observations after firing showed that this region was suffering physical distortion at muzzle exit. The velocity in these tests was around 2000 ms⁻¹, still a long way short of that ultimately desired for a weapon system. The distortion was felt to be due to magnetic separation forces caused by the current at muzzle exit trying to open the armature legs. There was some evidence for this, but it was not conclusive. No further material was removed from this region.

Attention was next paid to the armature legs. The baseline design had fairly thick parallel legs, which survived intact beyond 2000 ms⁻¹. The legs were tapered down and then subsequently thinned (Fig.2), without affecting in-bore performance. However, the recovered armatures showed that most of the current was carried at the edges of the legs, and that the central leg or part of a leg merely served to prevent leg collapse under the magnetic forces. Electrical conductivity is definitely of paramount importance in the current carrying parts of solid armatures.

Armatures made of different aluminium alloys in a variety of heat treatment conditions were fired at velocities around 2000 ms⁻¹. The results showed that a trade-off of room temperature mechanical strength for increased conductivity was worthwhile, even at 90 mm calibre. However, it was also clear that no single material had the breadth of properties for the highest energies and velocities.



Fig.1. Ultra-lightweight 90 mm armature

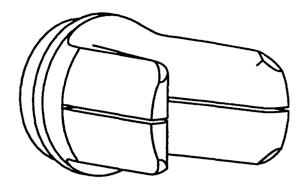


Fig. 2. Tapered leg 90 mm armature

Friction welding different aluminium alloys together had been tried at the smaller 40 mm calibre, with reasonable success, and this technique was employed for the production of full scale 90 mm armatures. A number of different designs of increasing complexity and optimisation were made and fired. The latest design employs a combination of A7075 with commercially pure aluminium at the corners of the legs where they contact the rail edges. The A7075 is positioned with the grain directions to suit the particular part of the armature. The details of this are reported elsewhere at this armature.

Trials have also continued at 40 mm calibre, looking at other problems associated with high velocity projectile launching. On many occasions, the centring bands have failed in-bore, and efforts are underway to rectify this problem. Changes to both the design and material used are being employed. Improvements have been noted, but the problem has not been totally solved yet.

The smaller calibre gun has also been used for initial trials of split armatures, as will be featured on any mid-riding armature/sabot design of projectile. A simple option as shown in Fig.3 has been successfully launched at 2000 ms⁻¹ and further work is planned with firings of more representative designs.



Fig.3. Split 40 mm armature before firing

Early ETC gun research concentrated upon establishing experimental facilities and techniques, developing plasma generator concepts and investigating plasma-propellant interactions. Work towards a fundamental understanding of these ETC processes continues whilst increasing emphasis has been placed upon the transition to large scale testing and the evaluation of applications. The UK ETC programme is focused towards indirect fire guns, principally artillery and naval fire support. ETC technology is considered capable of improvements in many aspects of an indirect fire gun system including; range, zoning, accuracy, consistency, logistics and survivability.

Research on fundamental aspects of ETC technology has recently included the further development of a mathematical model of capillary plasma generators, the measurement of plasma properties, and the study of plasma-propellant interactions.

EDENET is a one dimensional (1D) multi-species hydrodynamics code used to simulate the operation of capillary plasma generators. It is being developed for DERA by Fluid Gravity Engineering Ltd. Its main features are:

- an electrical circuit model;
- joule heating effects;
- wire vaporisation model;
- magnetic diffusion (1D radial);
- thermal and radiative diffusion (1D radial);
- electrode erosion;
- SESAME tabular equation of state / resistivity models.

Recently, radial simulations have been used for early times in the operation of the capillary plasma generator and have helped clarify the wire vaporisation process and subsequent plasma development. The information gained has been used to develop the axial version of the code into a multi-zone model to better simulate the radial temperature profile and thus the radiative energy transfer. Fig.4 shows some preliminary results where the predictions of a development version of the revised EDENET code are compared with experimental data.

Investigations into the use of plasma to increase the gas generation rates of solid propellants [2,3], have continued. Efforts to identify the mechanisms causing enhanced gas generation rates (EGGR) both during the electrical discharge (EGGRDED) and post electrical discharge (PEDEGGR) involve a theoretical study of the chemical reaction kinetics, a theoretical study of the heating of solid propellant grains and an experimental parametric investigation aimed at developing empirical relationships for use in internal ballistics codes. In two series of closed vessel tests using plasma jet and current injection modes the magnitude of EGGR was measured to be approximately proportional to the input electrical power. The development of empirical relationships has recently yielded tentative evidence for supporting a hypothesis that EGGR is a function of gas temperature and hence heat transfer to the propellant grain.



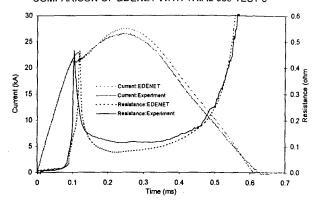


Fig. 4. Predicted and measured capillary plasma generator parameters

A number of both intra-chamber and extra-chamber plasma generator designs have been studied. The design closest to full scale realisation is the capillary plasma generator (plasma jet). Open air firings of an 18 mm diameter plasma jet recently achieved a peak electrical power of 3 GW, a peak current of 460 kA and dissipated an electrical energy of 3 MJ.

ETC scaling issues are being investigated with the aid of specially designed apparatus such as a "medium scale" test vessel (MSTV) and a 155 mm gun simulator. The MSTV is currently undergoing commissioning and will be capable of a peak pressure in vented vessel mode of 600 MPa, use propellant masses of up to 1 kg and up to fifteen instrumentation ports. The 155 mm gun simulator is depicted in Fig.5. The purpose of this device was to investigate plasma jet firings into low zone artillery charge modules with chamber dimensions and pressure history similar to those of a 155 mm artillery ordnance.

In particular it was to be a precursor to full scale gun firings, reducing the associated technical risks. A series of firings were undertaken at DERA Kirkcudbright with plasma ignition and conventional ignition followed by plasma injection at close to peak pressure. The results showed an elimination of ignition lag compared with

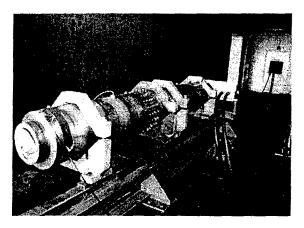


Fig. 5. ETC 155 mm ballistic simulator

conventional ignition and demonstrated EGGR during propellant burning. As the firings were consistent with predictions, preparations for full scale gun firings are continuing. The technique for increased gun precision through muzzle velocity control known as "Smart Gun" has been an active area of study [4]. This relies on an accurate prediction of projectile muzzle velocity within the first few metres of projectile travel along the bore so that an electrothermal impulse can be imparted to the projectile to increase the velocity of slow rounds. Where projectile muzzle velocity variations are a large fraction of the range error budget this concept has the potential to significantly improve artillery precision. Recent work includes an evaluation of fibre-optic strain gauges as projectile position sensors, the development of muzzle velocity prediction algorithms and tests to measure the velocity of propagation of electrothermal energy along a gun barrel. More details of this work will be presented elsewhere at this symposium.

Near-term future work will concentrate on the planned firing of a 155 mm ETC gun at the Kirkcudbright Electromagnetic Launch Facility. This is scheduled for July 1998. Figs.6 and 7 illustrate the gun assembly to be used. Early firings will use a plasma jet to ignite low zone charge modules and fire L17 projectiles. The aim of these tests will be to demonstrate improved internal ballistics of low zone unimodular charges by using ETC technology. Future work will aim to develop a true unimodular ETC charge system, investigate ETC advanced charges and demonstrate the smart gun concept.

IV. CONCLUSIONS

Research into electric guns in the UK is well established, and the demonstration of large scale performance is close. The EM work has shown that a hypervelocity weapon system is not a dream, but a realisable target. Understanding of the properties required of solid armatures has grown significantly and techniques to achieve the required combination of properties are being developed. This work will combine with work on novel projectiles to produce

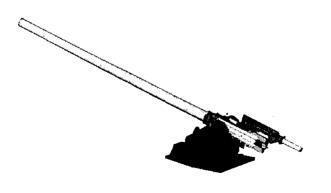


Fig.6. 155 mm ETC experimental gun assembly

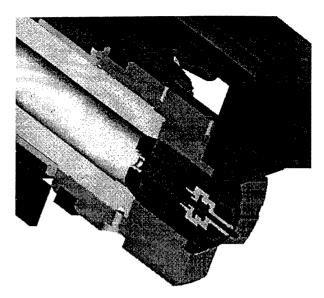


Fig.7. 155 mm ETC experimental gun: Breech and plasma generator

ballistic performance well in excess of that possible from conventional powder guns. The imminent availability of the Task C laminated barrel on loan from the US should help to provide even better launch conditions for these projectiles. ETC work has moved on from the early paper studies and small scale tests. Work towards a fundamental understanding of ETC processes continues, but more emphasis is being placed upon large scale testing. The programme is entering a phase of intense experimental activity using a large calibre 155 mm test gun. This will aim to validate theoretical predictions which are currently supported by small scale tests. It will also serve to highlight the issues involved in the realisation of an ETC weapon system.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge inputs from many members of the electric gun teams, notably Grant Hainsworth, Kevin Wales, and Gordon Thomson of the EM team, and Grant Savell, Steve Fuller and Clive Woodley of the ET team. This work was funded by the UK MOD.

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COL Hank Kinnison

TRADOC Systems Manager-Soldier

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- Infantry Mission
- Where We Are
- Land Warrior Enhancements
- Conclusion



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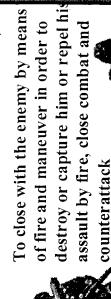
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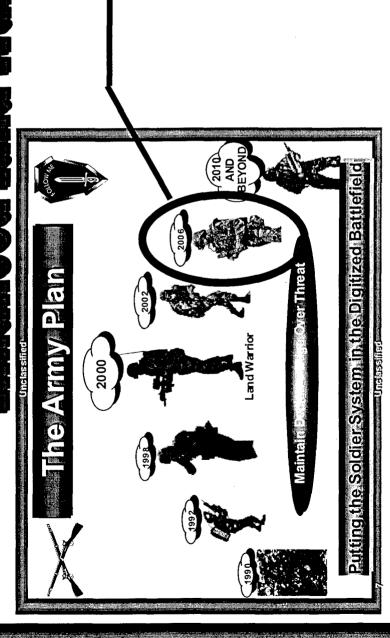


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Capabilities Overmatch

Keeping The Fight Unfair

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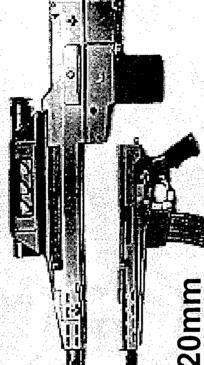
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- Fused Day/Night Sight
- Kinetic Energy 5.56 mm
- Laser Rangefinder
- High Explosive Air-bursting 20mm
 - **Ballistic/Environmental Sensors**
- **Electronic Compass**
- Wireless Link to Soldier
- Modular, Compact Integrated Fire Control







Laser Detectors

- Integrated Mission Rehearsal
- MILES Functionality
- Color Hand Held Display



- See-Through Helmet Mounted Display Lightweight Helmet w/ Suspension •
- Color, Fused Night Sénsor Display Component
- Expanded Field of View
- Interface with Weapon-mounted Sensors
- Situational Awareness Through Digital Maps and Reports

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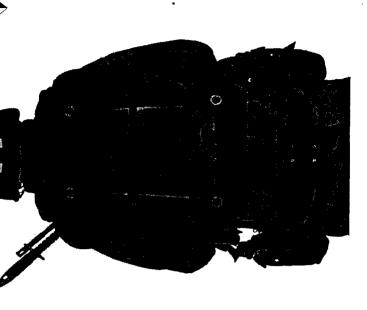




- Extended Ranges
- Joint Tactical Radio Integration
- Capable in Cities, Underground, Restricted Terrain



- Faster, Lighter, More Durable
- GPS / Integrated Navigation
- Color Handheld Flat Panel Display
- Combat ID and Miles Completely Integrated
- Voice or Manually Activated
- Powered by Hybrid Batteries and/or Fuel Cells



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INDIMIDIUAL EQUIPMENT SUBSYSTEM



- Lighter Through Continuous Research
- Bullet-Stopping Helmet and Modular Body Armor
- **Enhanced Signature-Reducing Uniform**
- Full Spectrum Camouflage
- Reduced Heat Stress
- Improved Chemical Protection
- Vital System Monitoring







The Infantry Will Prevail in the Close Fight

We Will Continue to Endeavor to Make The Fight Unfair

Capability Overmatch Will Continue to Be a Priority Infantry Branch Concept

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(Unreleasinge)

Armaments for the Army of the Future

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24 June 1998

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The U.S. Army
Soldier Systems Command







- Historical Soldier Load Data
- Load Carriage Research
- Representative Current Soldier Load
- Representative Land Warrior LoadSoldier Modernization Strategy
- Future Warrior Architecture Effort
- Lightweight Soldier for Army After Next (AAN) Science & Technology Objective (STO)





Throughout History, Load Variations Reflect -

- Conflict Between Equip. for a Wide Variety of Threats vs. Tactical Mobility
- Technological Changes Altered Nature of Warfare
- Middle Ages Armored Cavalry Displaced Infantry
- Arrows Penetrate Armor Lead to Resurgence of Light Infantry
- Disappeared As Firearms Became More Penetrating (late 17th century) Firearms Introduction Countered by 50 lb. Protective Shields - Shields



Loads Carried Documented In Literature*

- Crimean War British, French Estimated 63-73 lbs.
- British WWI 66 lbs.
- U.S. Forces North Africa 132 lbs.
- U.S. Forces Vietnam 74 lbs.
- Falklands Campaign 118 lbs.
- Grenada 120+ lbs.
- Joint Readiness Training Center average loads 88 lbs. (Knapik, et. al., 1990)
- * US Army Research Institute of Environmental Medicine, T19-89: Distinction not made between combat, approach, and/or sustainment



What Causes Soldiers to Enter Battle Overloaded?

- Three False Beliefs*:
- 1. Overloading With Ammunition Is Good for Battle Morale
- High Price Paid in Mobility, Heat Casualties
- 2. Ammunition Shortages Cause Tactical Disarrangements
- Defeat Due to Ammunition Shortages Least Likely to Happen
- Grenada: Excessive Loads Caused Difficulty in Maintaining Contact
- 3. Soldiers Should Be Prepared for Every Possible Contingency
- Beliefs = Effects of More Basic Cause: Battle Is a Realm of Danger and Uncertainty
- Mission, Enemy, Troops, Terrain/Weather, Time (METT-T) vs. Leader/Soldier Willingness to Assume Risk



Examples of Recommended Soldier Loads From the Literature

- Cathcart, et. al. 1923 Energy Cost Per Unit Weight Lowest @ 40% Body Weight
- Marshall, 1950 Optimal Training Load = 33% Body Weight, Optimal Fighting Load = 80% of Training Load
- U.S. Army Infantry Combat Developments Agency, 1964
- 30% Body Weight for Conditioned Fighting Soldier
- 45% Body Weight Soldier on the March
- Natick Studies, 1966
- 30% Body Weight for Conditioned Fighting Soldier
- 45% Body Weight Maximum Load
- FM 21-18, Foot Marches, 1990
- Fighting Load Not Exceed 48 Pounds
- Approach March Load (Includes the Fighting Load) Less Than 72 Pounds



1995 U.S. Army Anthropometric Survey Data:

Average Weight Male: 174 lbs.

30% average weight = 52 lbs.

40% average weight = 70 lbs.

45% average weight = 78 lbs.

Note: 11B soldiers tend to weigh slightly less than overall soldier population, but are better physically conditioned.

Demographic trends predict slight weight reductions in Army population through 2010





- If 40% Body Weight Is Boundary Condition:
- Target "Optimal" Load Weight = 70 lbs.

But...as a Design Criteria, This Weight Would Be Too Heavy for 50% of the Army Population

- If Choose 5th Percentile for Target Load....
- -40% of 136 lbs. =54 lbs.

95% of the Infantry Would Carry Loads Less Than or Equal to the Boundary Condition





Many Factors Influence Soldier Load

Carriage Capability

Soldier Height, Weight, Conditioning

Load Mass

Speed of March

Type of Terrain

Distribution of the Load

Volume of the Load



TR 97-023, DBS 97-031, 97-032, IN 97-310, 97-320

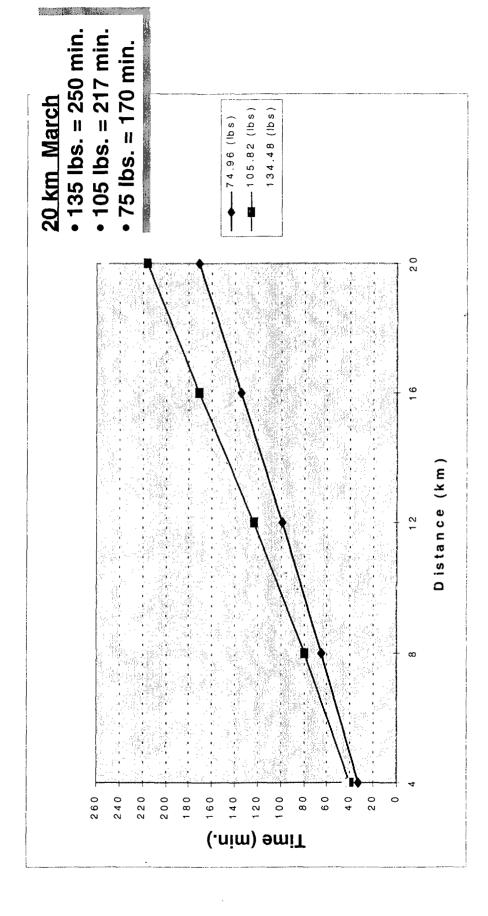
- Decrease the soldier's load while increasing capability.
- Payoff =
- Increase mobility and survivability of soldiers.

TR 97-044, DBS 97-020, AV 97-007

- Lightweight environmental and ballistic protection.
- Payoff =
- Enhanced soldier survivability and mobility.
- Allow soldiers to operate in all environments with less bulk and heat stress.

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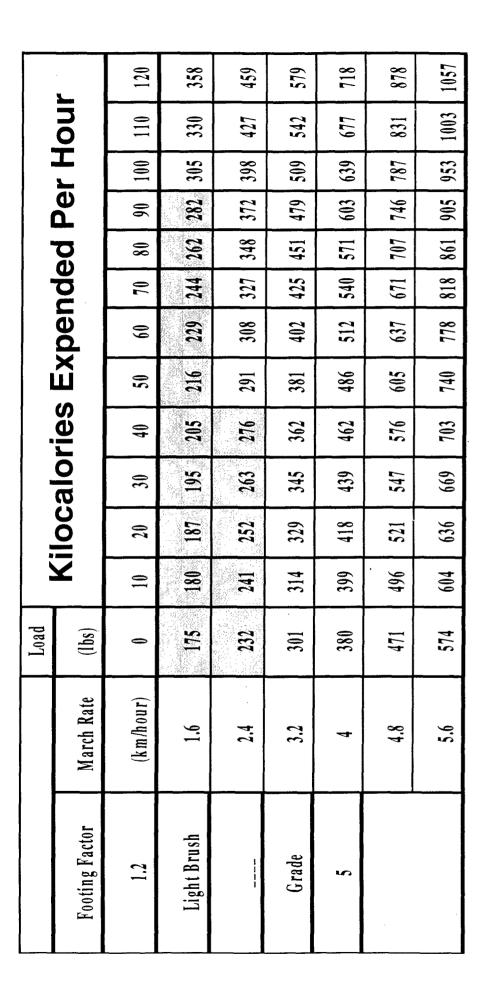




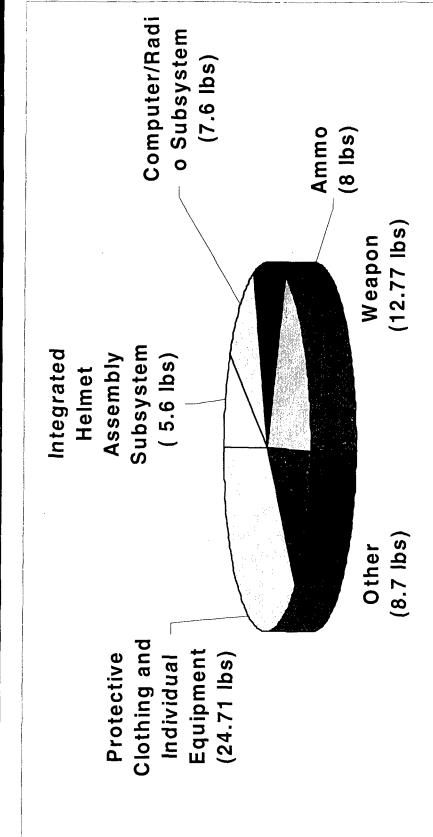


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1.2	(km/hour)	0	10	20	30	40	50	09	02	08	06	100	. 110	120
Light Brush	1.6	116	118	<u> </u>	125	121	139	149	160	74	190	209	231	256
	2.4	14	148	153	159	191	9/1	181	201	216	234	255	278	305
Grade	3.2	183	190	197	205	216	227	7 †[187	275	296	319	345	374
0	4	234	278	254	265	279	294	311	330	351	375	401	430	462
	4.8	296	309	323	339	356	375	396	418	443	471	501	534	570
	5.6	369	386	405	425	447	471	496	523	553	585	620	657	869







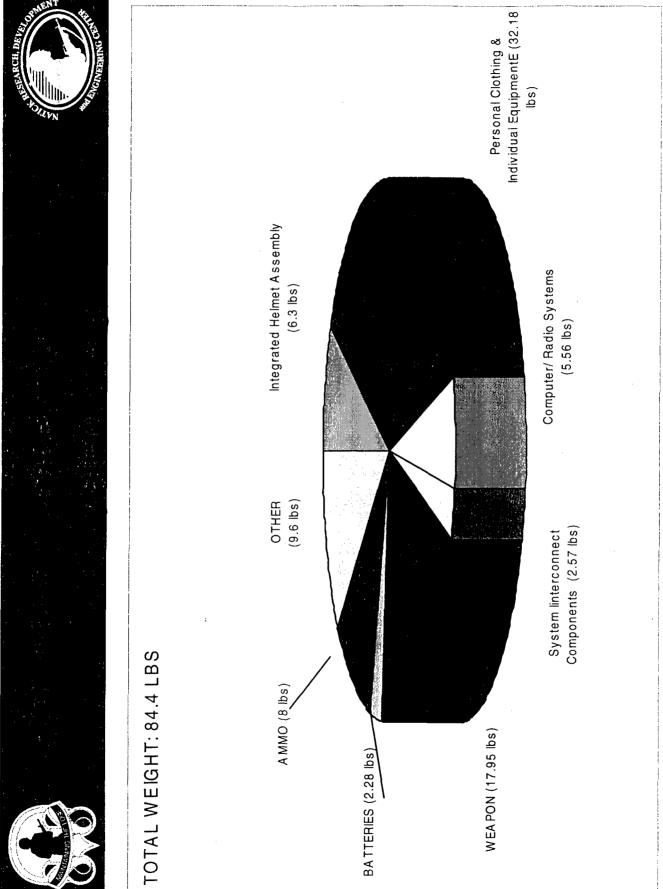


TOTAL WEIGHT: 67.4 lbs



STANGE OF THE ST	WEIGHT (16S).	8.9	9	4.2	4.1	4	3.6	3.4	3.2	m
	M16A4 RIFLE W/ M5 AR/ SLING	PASGT VEST	6X30 ROUND MAGAZINES, 5.56	WATER, 1QT.	BOOT, COMBAT	GPS/ SLUGR	PRC 126 W/ EXTRA BATT.	HELMET, BALLISTIC, (MED)	BINOCULARS, 7X35	PROTECTIVE MASK W/DECON KIT



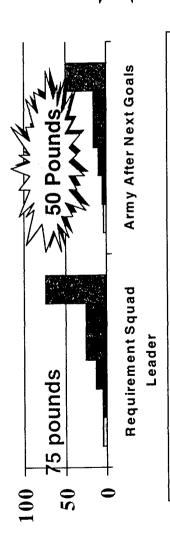






MEIGHIE (IBS) 8.4	7.7	6.8	9	4.95	4.4	4.2	4.1	3.9	3.2
<u>ITEMS</u> MODULAR WEAPON SYSTEM	BODY ARMOR	LCE FRAME W/ VEST PANELS	6X30 ROUND MAGAZINES, 5.56	THERMAL WEAPON SIGHT (TWS), HEAVY,	INTEGRATED HELMET ASSEMBLY	WATER, 1QT.	BOOT, COMBAT	M45 NBS MASK	BINOCULARS, 7X35





Protective Clothing

■ Weapon Subsystem

Other

Computer/Radio

Total

Helmet System

Wide Margin for Improvement for AAN

Requires Complete

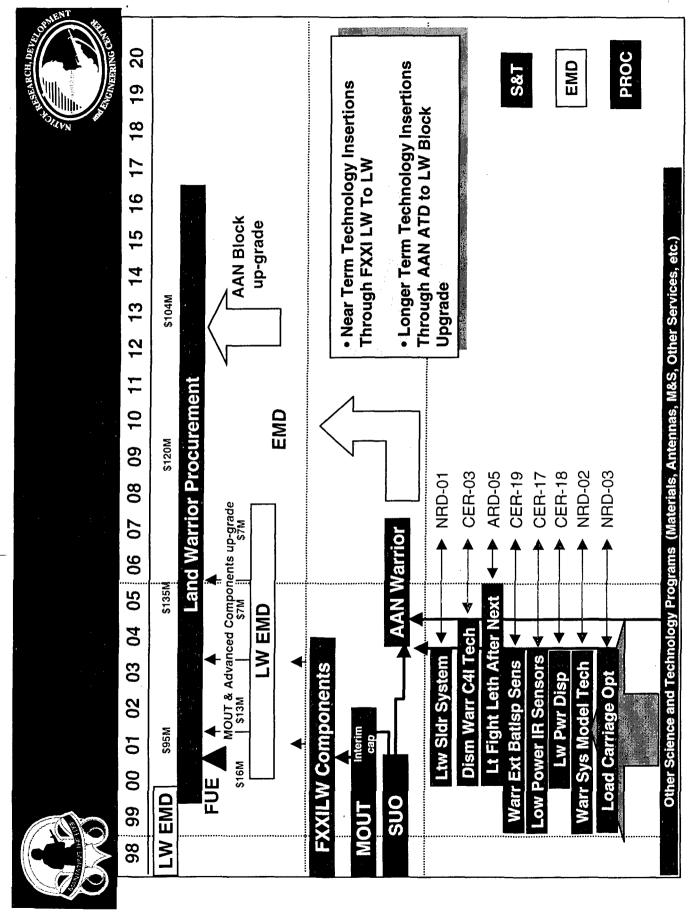
Systems Approach

Typical Sustainment Loads

🖪 Squad Leader 🗐 Team Leader 🔳 Rifleman

SAW Gunner Grenadier

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Define The Future Dismounted Warrior System Architecture

Reduce Weight

- Increase Tactical Mobility
- Reduce Workload & Fatigue
- Goal: 50 Pound Fighting Load

Reduce Power/Energy

- Reduce Weight, Volume, Life Cycle Cost
- Goal: 50% of Land Warrior Battery Requirement

Reduce Cost

- Increase Rate of Deployment, Force Coverage
- . Goal: 35% Reduction in LW/FXXI LW DTUPC

Improve Fightability

Increase Combat Effectiveness





- Urgency of the Problem Still Exists Loads Are Still Too
- Maximum Loads Must Be Matched With Human Physiological Capabilities
- Weight Constraints Must Be Instilled As System Design Criteria
- Technology Must Not Be Introduced Until Weight Constraint Is
- If We Care Enough for Our Soldiers
- Technology Will Be Forced to Achieve Load Reductions
- Commanders Will Enforce Specific Weight Constraints.

Advanced Kinetics: Small Arms Needs and **Concepts for AAN and Beyond**

Donald J. Butz and Robert I. Widder Columbus, OH and Crystal City, VA Battelle Columbus Operations 24 June 1998

Service Small Arms Program Office, under Army Research Office Contract No. DDAH04-96-C-0086, Delivery Order 0044 Based in part on a September '97 Workshop for the Joint

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Munitions and Ordnance

ndiajune98dib

Purpose and Approach

- Suggest challenges to long-term small arms development
- Present technology-based concepts from the JSSAP "Future Small Arms Blue Sky Conclave"
- This paper intends to
- Stimulate discussions/long-term thinking
- Suggest potential fruitful areas for exploration
- Set the stage to further refine and evolve concepts

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Definition of Small Arms

Definition has evolved

Objective Family of Small Arms is providing new capabilities, and setting the stage for new concepts

Look to 2020/2025 & beyond

 human/weapon interface and human factors Key areas of focus for R&D now include:

energy storage and power generation

fire control

energy delivery and target coupling

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Timeframes for Reference (Looking to 2025)

The Recent Past - 27 years Back

1971 (Vietnam conflict)

Nearly the same explosives and propellants

Many of the same small arms weapons

Little fire control on the individual weapon

Another 27 Years Back

1944 (WWII)

Propellants/explosives of similar energy density

Low penetration bullets and warheads

Some of the same small arms weapons as today

Essentially no fire control aids

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Definition of Advanced Kinetics

For the purpose of this presentation

Delivery of energy to a target via transport of mass (inert or chemically active)

This could include:

projectiles and warheads

unguided or guided delivery platforms

 focussed or directed macro-streams of mass (bulk mass, particles and/or gases)

Consider all enabling subsystems including fire control and human-weapon interface

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Important Elements of Army After Next

Deploy from much greater standoff

Operate in rapid maneuver more frequently

Build around increased small unit operations

Employ superior knowledge and decision speed

Provide superior weapons effects w/faster mobility

Be forced to work with some legacy systems

Utilize & extend capabilities of experienced leaders

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Likely Challenges to the Combatant

- More incidents involving sophisticated combatants
- Enemy with significant 'national technical means'
- Combatants & populace possibly highly intermixed
- More types of targets for small arms and individual soldiers, with reduced target signatures
- Longer lethal-ranges, but lower collateral effects
- Encounter weapons of mass destruction

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Challenges to Advanced Kinetics Development

- Greater lethality from lighter platforms
- Support increased mobility and pace of operations
- Using streamlined logistical support many fewer shots per kill will be needed
- Provide increased **lethal range**, but with **controlled** collateral effects
- Defeat harder targets having reduced signatures
- Use situational information in real time
- Coordinate target location and selection rapidly

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Potential Additional Challenges

- Support true joint service, internetted operations
- Coordinate actions/share data with more entities
- Use faster-than-real-time thinking/predictive solutions
- Work from an integrated, all-services technology base - less room for unique or individual needs
- Apply phenomena, concepts, technologies and components from other weapons programs
- Use non-defense R&D, enabling/critical technologies

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JSSAP "Blue Sky" Futures Conclave

- Ongoing effort to assess, project & stimulate small arms technologies and R&D
- Build upon then go beyond Objective Family of Small Arms (OFSA) concepts, systems, technologies
- Two-day gathering of broad subject matter experts
- Held September 1997 at Picatinny Arsenal, NJ
- Continuing to identify and develop concepts and enabling technologies for AAN and beyond
- Some results follow

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Small Arms Targets and Desired Effects

- Personnel
- armored
- in defilade
- Wider spectrum of materiel targets including
- light structures including many in urban areas
- light vehicles (ground, maritime and aerial)
- sensors (surface and aerial)
- critical infrastructure (comms, power, fuel, mobility, etc.)
- Requirement for controlled lethality (level of lethality, lethal radius, standoff range)

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Human/Weapon Interface

- Individualized weaponry ("oneness")
- Human brain/computer fusion (tailored information delivery - method and rate)
- Embedded training and status monitoring
- Weapon security/safety control linked to shooter
- Recoil management and reduction
- Potential human performance enhancement

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Fire Control on the Weapon

- Stabilized image and/or weapon-mounted sight
- Indirect sighting and shared sight information
- Image enhancement and fused multi-spectrum image
- Enhanced sensory capabilities
- inter-netted sensors and automatic use of situational data
- alternate sensory means
- active atmospheric compensation
- target signature enhancement
- IFF and target kill/damage assessment aids

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Guided and Smart-Guided Projectiles

- Ground-based guidance aids
- target seeker/sensor and navigational aids
- fire control and guidance/control computer
- data link to projectile having trajectory control capabilities
- Projectile-based guidance aids
- positional and attitude sensors
- flight computer
- seeker/sensor
- advanced terminal fuzing capabilities
- SACLOS (initial) or ACLOS (future) configurations

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Guided and Smart-Guided Projectile Concepts

Fly to a basket or a point in space

relative to computed or known target location

absolute (3-space) position and time

Sense projectile/target relative or absolute position

to permit choice of function time or location in space

to permit first use of directional warheads

Provide in-flight trajectory adjustments

compensate for communicated trajectory deviations

compensate for self-sensed trajectory deviations

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Energy Storage and Power Generation

- Means to provide energy in the proper form for
- Fire control (electrical, mechanical, or chemical?)
- Projectile or warhead launch (chemical, mechanical or EM)
- Projectile or warhead terminal effects (kinetic, chemical and/or EM energy

Sources

- batteries and fuel cells, including with power management
- truly advanced energetic propellants, explosives and incendiaries
- recoil process; energy from environment; motion energy?

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Energy Delivery and Target Coupling: General

- Projectiles (inert, reactive or explosive/energetic; ballistic or propelled)
- Warheads (ballistic or propelled)-bussed payloads
- Blast, thermal, and kinetic 'fragment' coupling at or near the target
- Projected gases/gas-particulates (contained vortices) and effective propagation and coupling to the target
- Focussed acoustics and shock waves

Advanced Kinetics Concepts: Projectile Launch

- How to achieve much faster flight to the target with acceptable recoil
- higher muzzle velocity
- in-flight acceleration or sustained thrust
- What are the true enabling technologies needed for practical small arms uses of:
- electro-thermal-chemical launch
- electromagnetic launch
- in-bore and free-flight ramjets or electro-thermal ramjets

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Advanced Kinetics Concepts: Launch and Propulsion

Use guidance capabilities to overcome dispersion errors induced by in-flight propulsion including:

solid rocket motors

solid-fuel ramjets

micro gas-turbine engines

Reduce recoil using

in-bore propulsion (travelling charges and rocket assist)

in-bore propulsion (ramjets of various types)

Active recoil profile tailoring

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Advanced Kinetics Concepts: Projectiles

Ballistics

- very fast spinning projectiles
- active drag reduction
- stability modification in flight
- in-flight sensing and compensation for dispersion errors
- gliding configurations

Structural Materials

- high density composite materials
- energetic materials having useful structural properties
- high force solid state actuators

Advanced Kinetics Concepts: Warheads

- Non-ideal detonation products tailored for alternate
- shock, blast and kinetic (fragment) energy balance
- kinetic and thermal energy balance: thermobarics, etc.
- still-reactive reaction products (incendiary or pyrophoric)
- Directional warheads
- asymmetric configuration (with knowledge of attitude)
- selectable initiation point?
- deformable warhead?
- High energy density materials: stable & metastable

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Advanced Kinetics Concepts: Warheads, Cont.

Pure shock/blast; blast/fragment; blast/frag/thermal

and/or solid phase fuel/oxidizer or energetic material Volumetric' warheads: dispersed gaseous, liquid

Hybrid penetrator/warhead arrangements

 hypervelocity reactive penetrator or hypervelocity macroparticle streams antimateriel payload with flechettes dispersed at the target

very high velocity warhead with low explosive dispersal of fragment or penetrator cloud

miniature submunitions

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Munitions and Ordnance

ndiajune98dib 6/22/98

Gases/Particulates, Waves and Shocks Advanced Kinetics Concepts:

- Generation and Propagation of Vortices
- delivery of energy as a gas or gas-particle slug
- delivery of kinetic energy with other additives
- Use of focussed acoustic energy
- Use of focussed shock waves

Other Concepts

- Alternate stability dynamically stabilized rounds
- Novel-material projectiles change compliance of projectile material or shape of projectile in flight
- Novel delivery platforms
- micro aerial vehicles
- ground-based robotics platforms
- Novel payloads
- target signature enhancers
- sensors for target or positional data

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Some Advanced Kinetics Challenges

- Apply 'large caliber concepts' to small arms needs
- Develop affordable, guided projectile capabilities
- Utilize both defense & non-defense technology base
- Design for graceful degradation and backup capability
- Realize that the basic human nature and key physical limitations of the individual soldier will still be there
- Individualize weapons and develop them treating a person as part of the weapon system

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Munitions and Ordnance

Important Small Arms Subsystem Concepts

Improved fire control

Human-weapon integration

Recoil effect attenuation

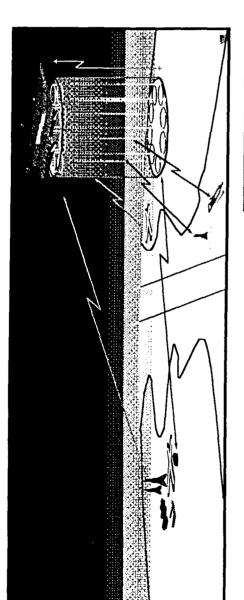
Guided or smart projectiles

In-flight propulsion and higher speeds

Projectile stability concepts

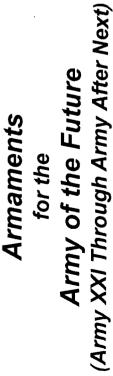
Advanced fuzing



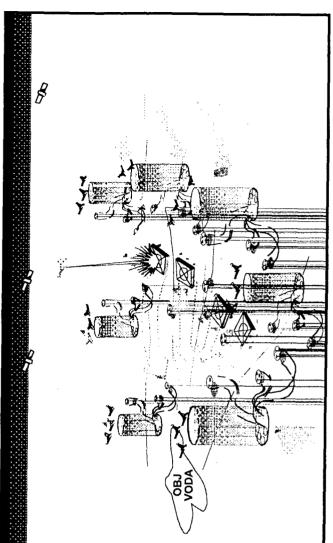


Technology for Army After Next Fires

John M. Miller Walter F. Morrison U.S. Army Research Laboratory



Parsippany, NJ June 22-24, 1998





Technology for AAN Fires A Work-In-Progress Report

-

AAN Fires Integrated Idea Team (IIT)

Notional System Concepts

Original AAN Concepts

New Concepts for Further Study

Critical Technologies

Way - Ahead





FIRES IIT

PURPOSE

- Investigate current and potential AAN FIRES Concepts and Notional Systems
- Take first steps in moving from notional systems description toward simulation for AAN systems.

PROCESS

Bring together members of the National S&T community with the military operational community.

- Workshops
- ARTAC NET

ORGANIZATION

- Sensors
- Effectors
- C4I
- Physical

PRODUCTS

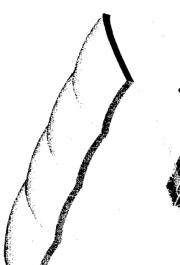
- Models of FIRES Notional Systems for simulation in AAN
- Identify critical technologies for AAN

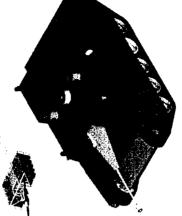
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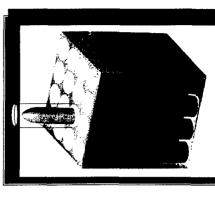
Projovosad Revision to Original VAM Comegas

□ Increased Survivability and Flexibility of AFSS

- Various Missile Types/Functions
- Antitank, Air Defense, etc.
- > Parafoil Emplacement Option
- Various Size "Boxes" Mountable on Trucks, etc.
- Advanced Fighting Vehicle (AFV)
- Active Protection Concepts, Including DEW
- Alternate Lethality Packages
- Missile Pod with Robotic Engagement System
- 120mm Rifled Mortar with PGMs and Fire on the the Move
- ⋄ 30-75mm ETC for Direct Fire
- Objective Crew Served Weapon (OCSW) as Secondary Armament
- Smart Pallet Re-Supply (Parafoil or Parachute Deployed)
- □ Advanced High Mobility Vehicle (AHMV)
- Mini-POD of Missiles
- OCSW Remotely Sighted with Crew under Armor







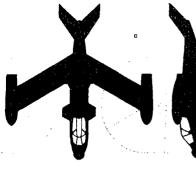


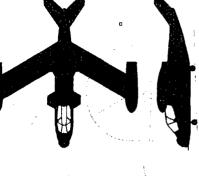


Proposed Revision to Original 44M Concepts

- Advanced Utility Transport Vehicle (AUTV)
- Can Carry Missile Pod plus Cargo
- Advanced Attack Air Frame (AAAF)
- Active and Passive Countermeasures to Minimize Signature
- for Air-to-Air and Air-to-Ground Capability Advanced Multi-Mission Missiles (AMMM)
- Advanced Target Acquisition System
- Advanced Fire Support Aircraft (AFSA)
- Can fire AFSS In-Flight or Hover
- Incorporates Countermeasure Capabilities















Nevir Comadols (or Entitle State)

- □ Indirect Mass Precision Fires
- Lightweight 155mm Cannons
- Smart Munitions with Course Correction
- Terminal Guidance by AAN LAN, Soldiers, etc.
- □ CONUS-Based Global Precision Strike
- "Blast Wave Accelerator" Cannon

Target

Artillery

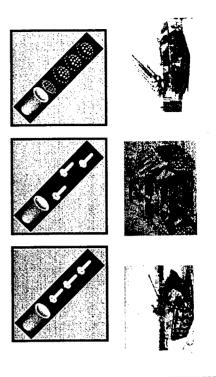
Management **Effects**

FO / Sensor

○ 1000 lb Projectile



- Multi-Mode / Multi-Effects Warhead
- EFP Warhead
- Defeat Armor, Soft Targets, and Personnel
- Applications to APS







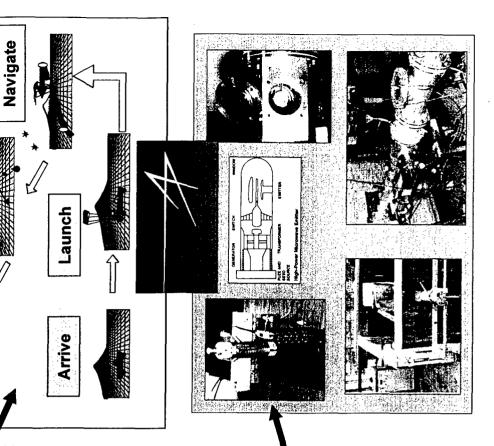
New Concepts for Further Study

Volume Denial Dynamic Barrier

Deploy

Relay

- Shape the Battle Space
- Delay & disrupt enemy attack & movement
- Retard enemy's dash to complex terrain
- Cut off routes of withdrawal
- Isolate and Immobilize Enemy Forces!
- Ambush
- MOUT Capability
- □ Advanced Micro UAV Counter Piece Weapon
- Fly's Down Gun Tubes
- Non-Lethal Weapons -
- HPM Warhead (Anti-Materiel)
- Volumetric Munitions (Anti-Personnel)
- ⋄ Couple to "Bio" Freq's, e.g. Chest Cavity

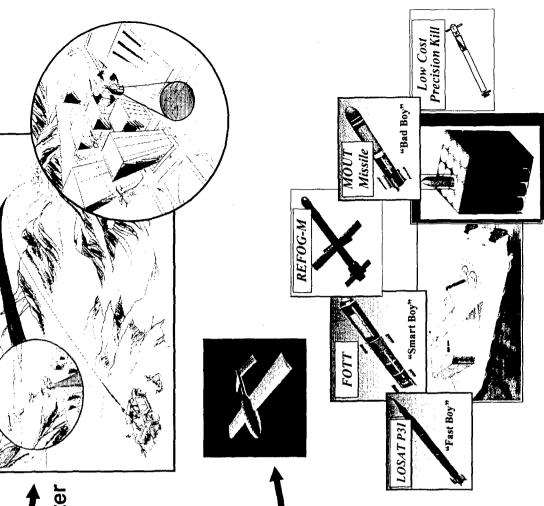






MONT CONFOCIONS/10/ PUTABLE

- □ Dragon Fly
- Mortar Fired
- Mini-Helicopters with 6-8 Hour Loiter
- Sensor and Shooter Capability
- Smart Sensing Precision
 Projectile-Munition
- Non-Penetrating Kill of Armored Vehicles
- Counter-APS Capability
- □ QuickLook Targeting System
- 155mm Howitzer Launched UAV
 - Range to 50km
- Acquire and Relay Targeting Data
- □ Advanced Missile Concepts
- LOS and NLOS for AFV
- AFSS Applications







New Concepts for Further Study

□ Multi-Role Munition Variants ■

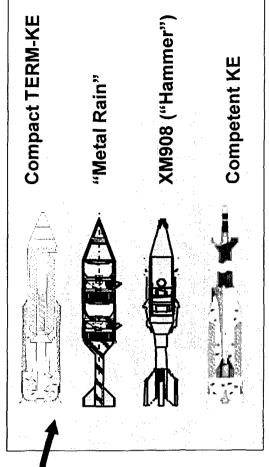
- Leverage Current Concepts/Tech
 - ▼ TERM-KE Concept
- SADARM Block II Concept
 - ⋄ M8301A1Derivative
- ⋄ M829E3 & Follow-on Technology
- Cannon Launched

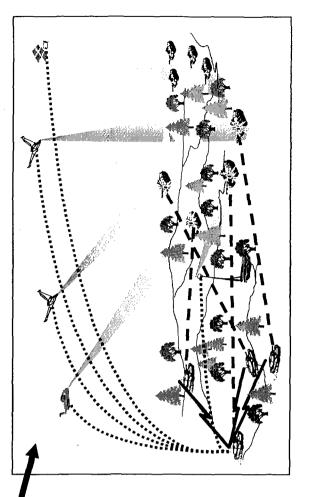
Distributed Interactive Fire Mission

- Optimize Fire Control Detection Thru Engagement
- Linked Weapon Platforms Act in Concert
- Implementation of TERM

□ Very High Altitude - Low Earth Orbit Deployment from CONUS

- "NASP"-like Cargo Bus
- Deploy Un-Manned AFSS and Volume Denial Systems
- ⋄ Block Movement of Enemy Forces
- ⋄Secure / Protect Landing Zones for Air-Mech Battle Force







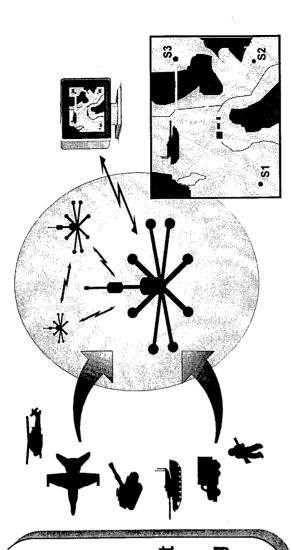




Unattended Ground Sensor (UGS) Concept

DESCRIPTION

Unattended Ground Sensors will provide unique target acquisition, target engagement, & force protection capabilities. UGS can be stationary (SLUGS), mobile (MUGS), or tiny insect sized tags (Bugs). A diverse sensor suite will allow accurate target tracking and identification.



KEY TECHNOLOGIES

- Sensors acoustic, seismic, magnetic, IR, etc.
- Commo local & long haul
- Sensor fusion
- Location & orientation
- Robotic platforms
- Power sources

APPLICATIONS

- Sensors for area denial systems
- Local force protection
- Choke point monitoring
- Long range surveillance
- Individual soldier self protection

June 1998

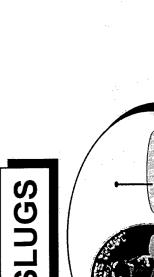
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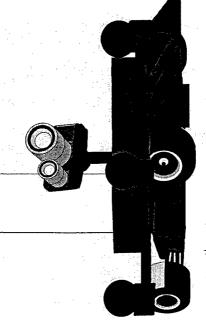
UGS Concept

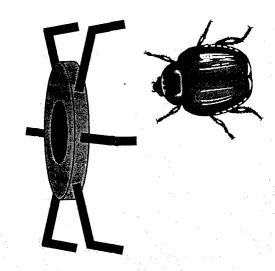


MUGS









Very diverse sensors High performance Mobile

Signature enhancers Attach to targets Very small

John Miller, ARL

12

Modest performance

Very inexpensive

Small

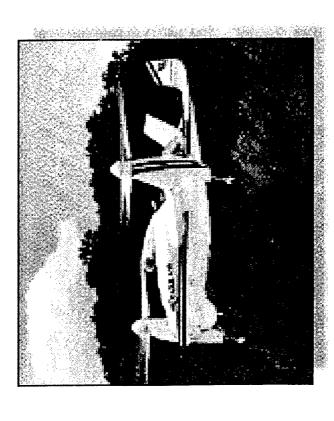




Surveillance UAV Concept

DESCRIPTION

Long (24 hr) endurance UAV carries EO/IR, SAR/MTI and FOPEN SAR sensors. On-board processing supports target ID, tracking and change detection. Carries, dispenses and coordinates ground sensor arrays. Detects and tracks low flying cruise missiles.



KEY TECHNOLOGIES

- Low-power, high-speed signal processing
- High fidelity sensors
- Robust, covert communications
- Multi-sensor fusion

APPLICATIONS

- Wide area surveillance--handoff ID and location to FU and targeting UAV
- Carry and dispense smart ground sensor arrays
- Relay and coordinate data for ground sensor arrays (UGS "mother ship")

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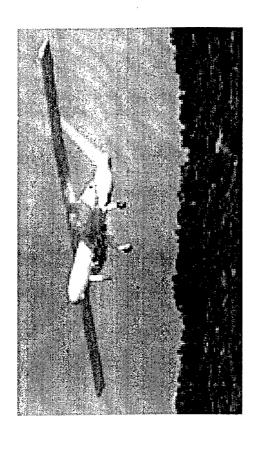
Targeting UAV Concept

DESCRIPTION

Short (5 hr) endurance UAV carries EO/IR, SAR LADAR and Laser designator. Sprints to target area with disposable jet pack or fired from rocket launcher. Loiters in target area during fire mission. Disposable or lands and uses coded beacon for later recovery.

KEY TECHNOLOGIES

- Low-power, high-speed onboard signal processing
- High fidelity sensors
- Robust, covert communications
- Multi-sensor fusion



APPLICATIONS

- Forward "eyes" for targeting and BDA
 - Precise location and ID sent to FU
- Laser designation capability

Update target data to smart weapons

w/o booster, provides close-in perimeter surveillance for FU protection

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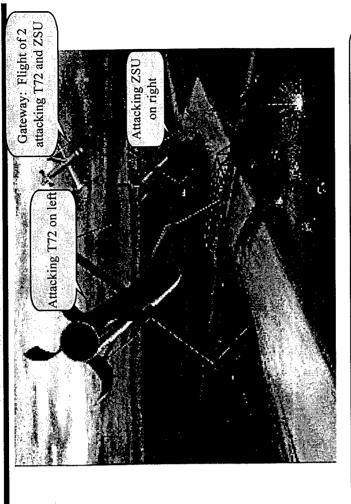
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Networked Smart Munitions

DESCRIPTION

- Receive and process intelligence data while enroute to target area
- Network smart munitions carried on bus to coordinate attack
- Use smart munition sensors to provide target intelligence data and real time BDA



KEY TECHNOLOGIES

- Highly robust, covert communications network
- · High fidelity sensors, i.e. ladar etc.
- Robotic intelligence
- High speed intelligence data processing and dissemination

June 1998

APPLICATIONS

- Anti-armor/vehicle attack
- High value target attack
- Deep fire attack
- Real time BDA after attack

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ナベト



Critical Technologies and Capabilities for AMN

□ WEAPONS AND MUNTIONS:

- Higher Energy AND Lower Vulnerability Propellants & Explosives: Warheads-Missiles-Guns
 - High Strength, Lightweight Materials, including Lightweight Armor Systems
- Smaller and More Lethal Munitions and Lethal Mechanisms
- Multi-Mode Warheads: Hard Targets, Soft Targets, Aircraft, Personnel
- Increased Stowed Kills in all Vehicles
- Remotely Operative "Robotic" Weapon Systems, e.g. AFSS and Volume Denial Systems
 - Recoil Management of Gun Systems
- Clip Fed Automatic Loading for Robotic Gun Systems
- Tunable DEW
- Advanced Gun Propulsion: ETC or EM
- Modular Construction of Weapons and Munitions, e.g. Easily Upgraded, Reprogrammed, or Replaced Components

SENORS AND BATTLEFIELD INTEGRATION / MANAGEMENT:

- Advanced Sensors: e.g. LADAR, Miniaturization, Intelligence, etc.
- **Detection of Enemy in Complex Terrain**
- MEMS and Nanotechnology
- Real-Time Integration of Field Artillery "Effects Management Centers" with overall C4I Concepts
- Modular, Distributed Weapon Systems; Aggregated Based on Threat
- Real-Time Battlefield Damage AssessmentMicro UAVs





Critical Technologies and Capabilities for AAN

□ MISCELLANEOUS:

- Micro UAV Technology
- > Parafoil Technology
- Stealth Technology for Ground and Air Systems
- Effective Tagging Materials which can be Seen from Long Distances
- Smart Pallets (AFSS, Volume Denial, and Logistics)
- Significantly Reduced Time to Air Drop and/or Emplace Forces
- Ability to Neutralize Large Areas in a MOUT Environment; Could Energize an Approach to Avoid Certain Areas, e.g. Island Hopping Concept Applied to MOUT Environment
- Decoys: Have the Enemy Confused as to where Forces are Located, e.g. Have "Used" AFSS Boxes (Missile in a Box) Generate EM Signatures of US Combat Vehicles/Systems 0

720



Siejojajyjyjyj Siejojajyjyjyj

- 2025 Weapons and Munitions Should be Usable by ALL FORCES
- Air-Mechanized Battle Forces... may employ new platforms
- Campaign Forces... existing platforms; exploit new effectors
- Naval and Air Fires... can new effectors be exploited?
- Competent Smart Brilliant Weapons and Munitions
- Must be Cheap, Effective and Ubiquitous
 - CM CCM etc. Becomes an Issue
- Should be Either Competent or Brilliant
- Competent: Smart Enough for High P_H Dumb Enough to be Immune to Spoofing
 - Brilliant: Knows when its being Attacked and Responds Accordingly
- Capabilities for Complex Terrain will be Critical
- AAN Based on "Knowledge & Speed" Complex Terrain Negates Both!
- Stand-off Range is a Key Parameter
- Sensors to Provide "Knowledge" a Must
- Volume Denial Weapon Systems to Isolate / Immobilize Enemy Needed
- Is Containment/Island Hopping a Viable Option?
- Physically De-Coupled "Shooters and Effectors"
- Un-Manned Systems can Fire Majority of Munitions
 - Targeting and Decision to Fire at Low Level
 - Manned Vehicle
- ⋄Individual Soldier on the Ground
- Sensors in Robotic Systems
- ⋄ Must be consistent with Command Authority

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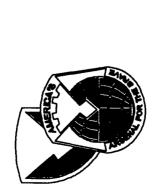




 Continue to develop / refine notional systems concepts and control technologies

Prepare report surveying findings and recommendations

Support TRADOC in developing and implementing models to validate capabilities and benefits.







Digitized Architecture

Armaments for the Army of the Future

Symposium and Exhibition

24 June 1998

Presented by:

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The Digitized Army



TG Guenther provided the common vision of the future for the Army:

all the tools necessary to convey thoughts, orders, or plans "Everyone on the battlefield can interact at anytime using to any system, mounted or dismounted, on the battlefield in real-time."

Nov 4, 1996

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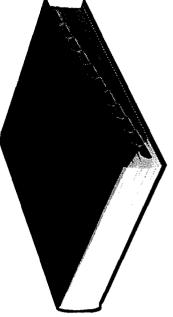
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Definition of Technical Architecture





"A minimal set of rules governing the arrangement, that a conformant system satisfies a specified set elements of a system whose purpose is to ensure interaction, and interdependence of the parts or of requirements."



6-Identifies the services, interfaces, standards, and their relationships. Ger Provides the technical guidelines for implementation of systems upon which:

- Engineering specifications are based
- -Common building blocks are built
- Product lines are developed

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Purpose of

Technical Architecture



62 Enhance Interoperability and Reuse

€ Decrease Development/Maintenance Costs through reuse and standardization

Streamline development process/requirements

62/Enforces open system standards

a modular, component based development/reengineering Enhances flexibility, evolvability and extensibility through process

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Scope Of The Army Technical



Architecture

electronically. The target audience is anyone involved in the development of The ATA applies to all systems that produce, use, or exchange information new or improved systems.

Technology Demonstration (ACTD) Manager responsible for incorporating the Within the Army, the Vice Chief of Staff, Army and the Army Acquisition Executive Officer (PEO), and Program/Product Manager (PM), Advanced Technology Demonstration (ATD) Manager, and Advanced Concept and Executive have jointly made each Milestone Decision Authority (MDA), Program specification of the ATA into their respective programs and products. Materiel developers will use the ATA to ensure that products meet interoperability performance and sustainment criteria. Combat developers will use the ATA in developing requirements and functional descriptions.

unduly delayed by the cost and time required for wholesale reengineering to meet ⇔ Battle Labs will use the ATA to ensure that the fielding of their "good ideas" are not specifications.

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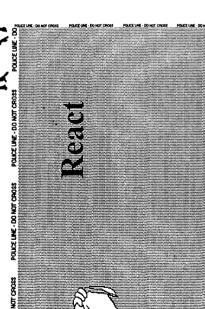


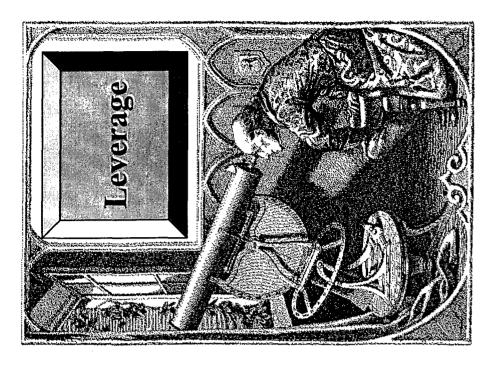
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The Three Architectures



Operational Architecture is missions,

Architecture

System

requirements, and business rules functions, tasks, information

implementation of the OA, the layout and relationship of computers and System Architecture is a physical

Architecture Operational

"building code" upon which systems Technical Architecture is the are based

Architecture

Technical

communications

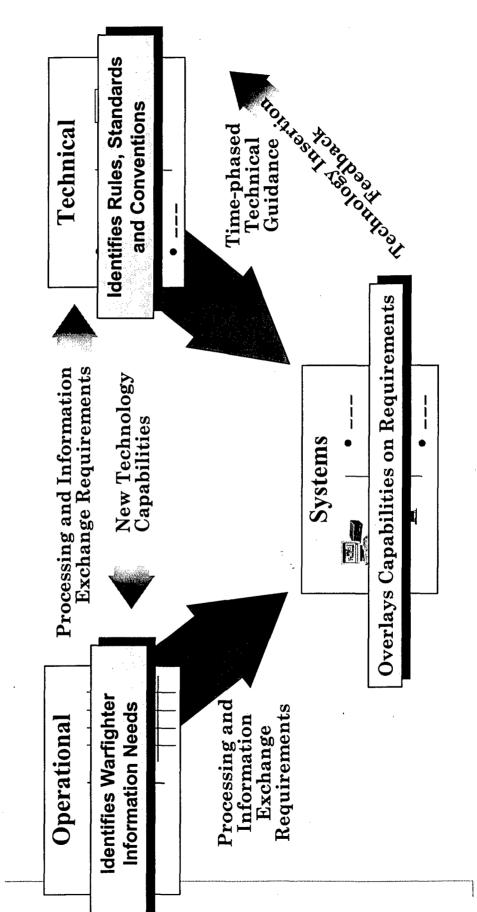
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ARCHITECTURE INTERACTIONS





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Digitized Architecture

JTA Document Hierarchy

(Core Identified and Domain Annexes Added)

JTA Core



Automated Test Systems Finance/Accounting Logisitics Materiel H R Management Acquisition MedicalLegalSupport Combat Modeling & Simulation Committed to Excellence Sub-domain Annexes JTA Main Body **Ground Vehicles** Missile Defense Soldier Systems Space Vehicles Ship Systems Domain Annexes Munitions Aviation MissileJTA Core Systems Weapon Elements Surveillance/Reconnaissance Airborne Reconnaissance Command & Control Communication Info Warfare Intelligence C4ISR V2D1 Populated V2D2 Populated Sub-domain Elements Elements Domain

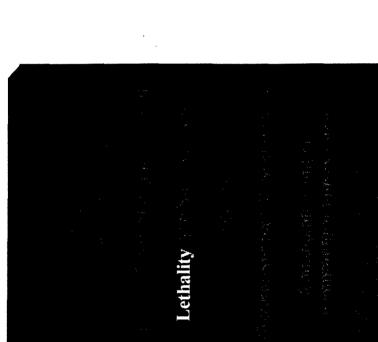
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Weapon's Commonality

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☐ Digitized Architecture



Digitization Operability Types



A Homogeneous Interoperability is interoperability with other like systems (e.g., a full Paladin battery)

A Heterogeneous Interoperability is interoperability with different systems (e.g. Abrams, Bradley, etc.). A Intraoperability is the impact of the integration of the other systems [e.g., EBC, Joint Mapping Tool Kit (JMTK), etc.] on system performance.

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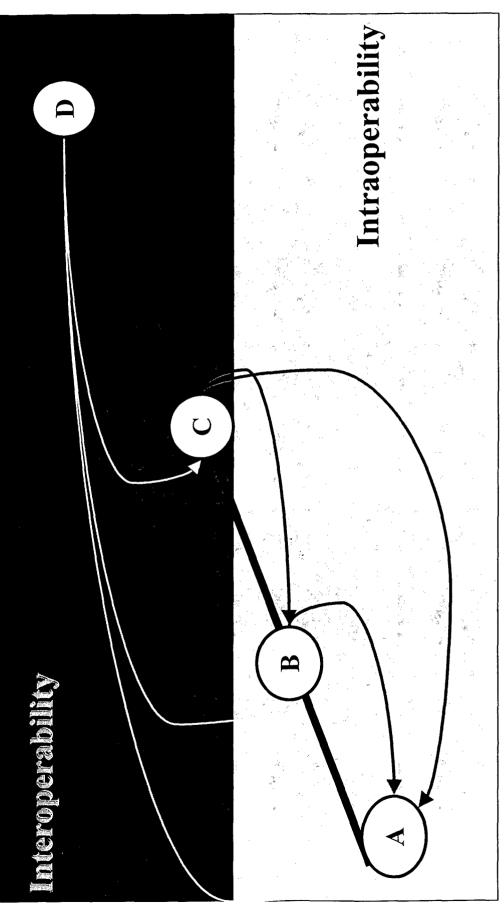
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Digitization Phases

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Summary



needed for systematic integration of Digitization Support Elements To achieve interoperability of a force, i.e. FDD, FDC or FDA for that matter, a common technical guidance across the Services is (DSEs) within architectures. This is being driven by: 6-Digitization and Architectures being separate parallel endeavors

AFuture operations will increasingly be Joint

A Digitization Demands Increasing

62 Weapon Systems Software Requirements Growing

 60° Hardware standards in both the JTA 2.0 & JTA-ARMY 5.0

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BackUp Slides

Digitized Architecture



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Digitized Architecture

Standards Selection Criteria

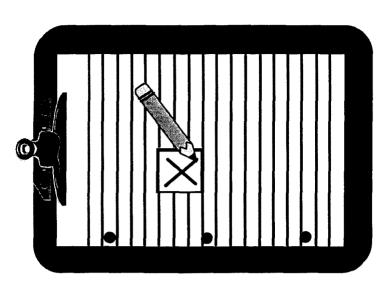


Criteria

- Critical to interoperability or business case
- Mature service, interface, or standard
- Technically implementable
- Publicly available
- Consistent with authoritative sources
- Prudent balance of multiple criteria

Order of Precedence

- International industry
- National industry
- Government
- **Military**



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DOD Architecture Efforts







(Integrated Architecture Panel)

Addressing operational, systems, and technical architecture <u>processes</u> and

C4ISR Integration Task Force

Technical Architecture Framework for Information Management (TAFIM)

Establishes DOD framework/processes for defining technical architecture

Not a specific technical architecture

The JTA supersedes TAFIM Volume 7 for C4I systems

The JTA will continue to use the C4ISR

structure

Establishes a technical architecture for C4I interoperability



Common Operating Environment(s)

Instantiation of C4I Technical Architecture focused on (but not limited to) Information Processing

Common Support Applications

Standard APIs

Apps

Infrastructure Services

karilat - Operating System

The JTA mandates the use of the COE

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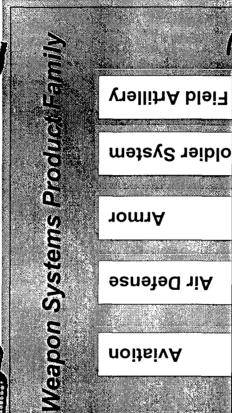


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Lethality Services







Armor

Air Defense

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Basis for Re-Architecture usable Fire Contro/

Decision/Prioritization Services

Acquisition/Prediction Services

WHEUTEN

Engagement Services

Damage Assessment Services

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"Marks-On-The-Wall"



Army senior leaders have set "Marks-On-The-Wall" for systems to comply with the JTA-Army:

Amandated that by the end of 2000 all Division XXI systems must meet the critical interoperability standards identified in their migration plans Aby the end of 2006 ALL systems must meet ALL applicable JTA-Army standards.

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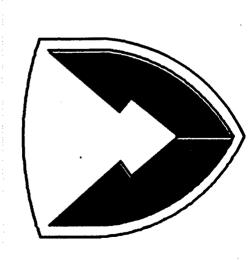
WOOW.

Fire Control for the Army After Next





U.S. Army Armament Research, Development, and Engineering Center



Charles Seitz

Fire Control & Software Engineering Division Indirect Fire Branch

U.S. Army Materiel Command

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ASSUMPTIONS





- Limited to 2025 time frame
- Guns & Bullets remain primary
- Compatible with current weapons
- More automation
- Better performance



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FUTURE PERSPECTIVE

- Essential fire control system functions will remain the same
- Novel mission scenarios & tactics will challenge designers
- Performance keys -- Computers & tactical database management
- Complete knowledge of total tactical scenario
- Prioritized mission information -- non-critical data filtered
- Networked firing units for optimal joint effectiveness



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SYSTEM INTEGRATION

- Fire control systems integrated into the digital battlefield
- Tactical data continuously streams from satellites
- Decision aids sort through targeting & tactical options
 - Fire missions coordinated through command net
- Object Oriented hardware & software design philosophy
- Base modules common to all applications
- Functions extendible to a generic application
- Functions overridden for a very specific application







CORE FIRE CONTROL TECHNOLOGIES

ANDIN

- Sensors (onboard & internal, remote & external)
- Processing hardware
- Software languages and architectures
- Ballistics and aiming
- Controls and displays
- System reliability and maintainability
- Manufacturing processes



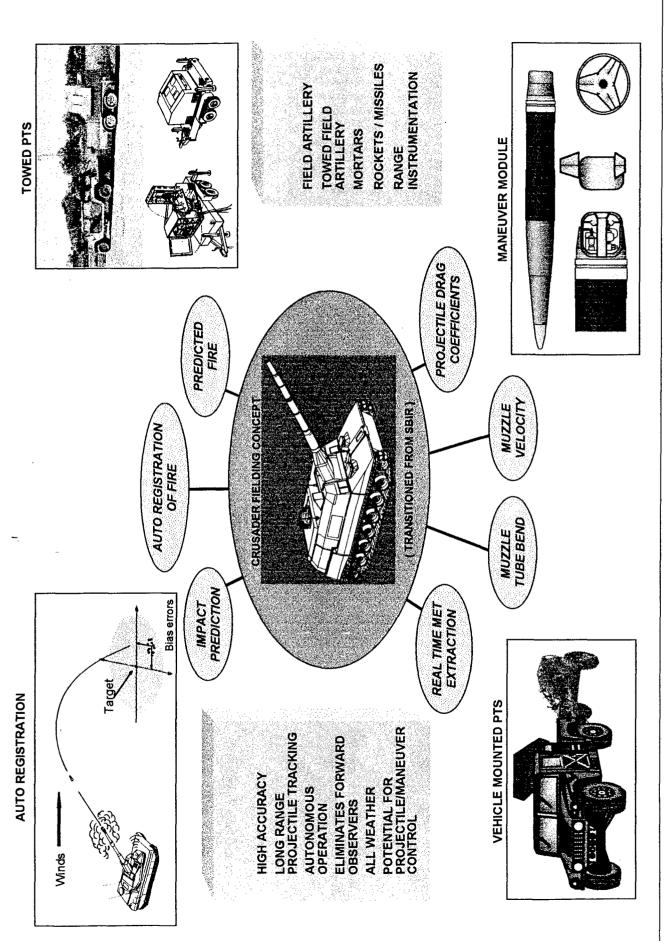
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- Multiple sensing channels share common optics
- Microwave devices for target imaging and munitions guidance
- True sensor fusion finally achieved
- Micro-machines tag targets
- Robotic targeting sensors deployed away from firing site

PROJECTILE TRACKING SYSTEM





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DATA PROCESSING

Hardware

Highest computational speeds attained Megascale chips at manufacturing limits Non-transistor architectures emerge Revolutionary mass data storage devices

Software

One totally flexible programming standard Dynamically configurable architecture True multi-tasking operating system

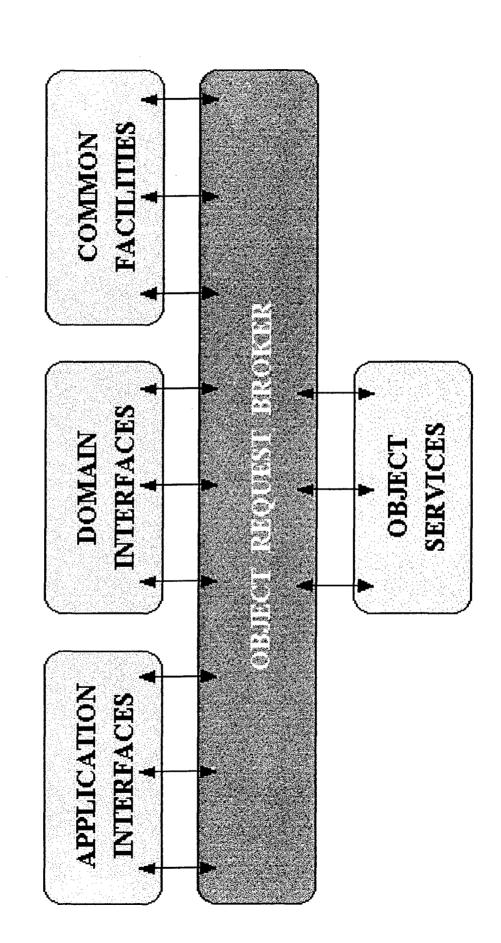


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SOFTWARE ARCHITECTURES





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BALLISTICS & AIMING

SHOME

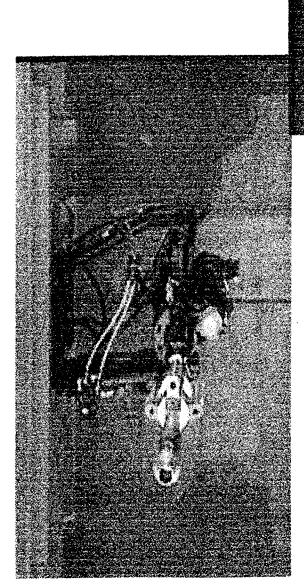
- All ballistic weapons employ a fire control processor
- A platform independent Ballistic Kernel computes firing solutions
- Precise dynamic ballistic performance parameters
- Robust 6 Degree Of Freedom trajectory simulation
- Modeling of computational fluid dynamics
- Extended functionality
- Miss distance sensing eliminates biasing errors
- Aim errors canceled through in-flight control of projectiles
- Real-time battlefield MET data
- Novel techniques for weapon stabilization developed







NOVEL GUN STABILIZATION TECHNOLOGY







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YOU BUY OUT OF TO TOO OUT





CONTROLS AND DISPLAYS

CHOKY

An extension of the soldier

Controls

Controls integrated with virtual reality (VR) System responds to mental commands System responds to verbal commands Primary manual controls remain

Displays

Conventional optics replaced by emitter arrays High resolution stereo displays bolster VR Tactical images sent directly to the eye





RELIABILITY & MAINTAINABILITY

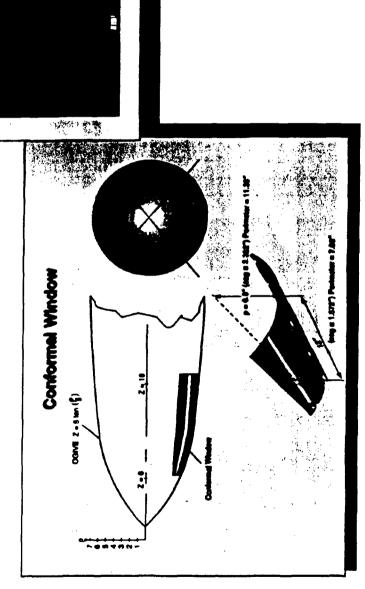
CHOHY

- Multiple redundancy for critical functions
- Failed items dynamicaly auto-repaired through self-diagnosis
- Field configurable modules minimize down-time
- Reprogramming of system functions by common support devices
- Remote troubleshooting through battlefield digitization

Conformal Optics

DARPA Physical Optics Program (TI, Boeing, RPC, Sinclair, COM)

Multi-Spectral Off-Axla Optioni System











• Plano (only x-axis motion)

• Concave - greater than 200 mm

Convex vertical wheel rim supporting MR fluid is a section of a 150 mm diameter sphere.

• Part to wheel rim gap $\approx 1.0 \pm .05$ mm

• Wheel 0 – 1,000 rpm

• Spindle 10 – 300 rpm





WOOV.





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SUMMARY

The future is different ...

Orders of magnitude increase in sophistication System complements the soldier Greatly expanded functionality

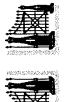
Yet, it is familiar ...

Prime movers will accomplish weapon positioning Sensors gage relevant engagement parameters Customary crew tasks will be performed Soldiers in control ... with confidence Processors will manipulate data



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TIP COLD OF TO VERY AREA





THE FIRE CONTROL AAN GROUP

Group members

Stan Kopacz Greg Malejko Kenn Pfleger Charles Seitz André Sowa Mike Szekula

Group facilitator

Adrienne Chenique Sapp

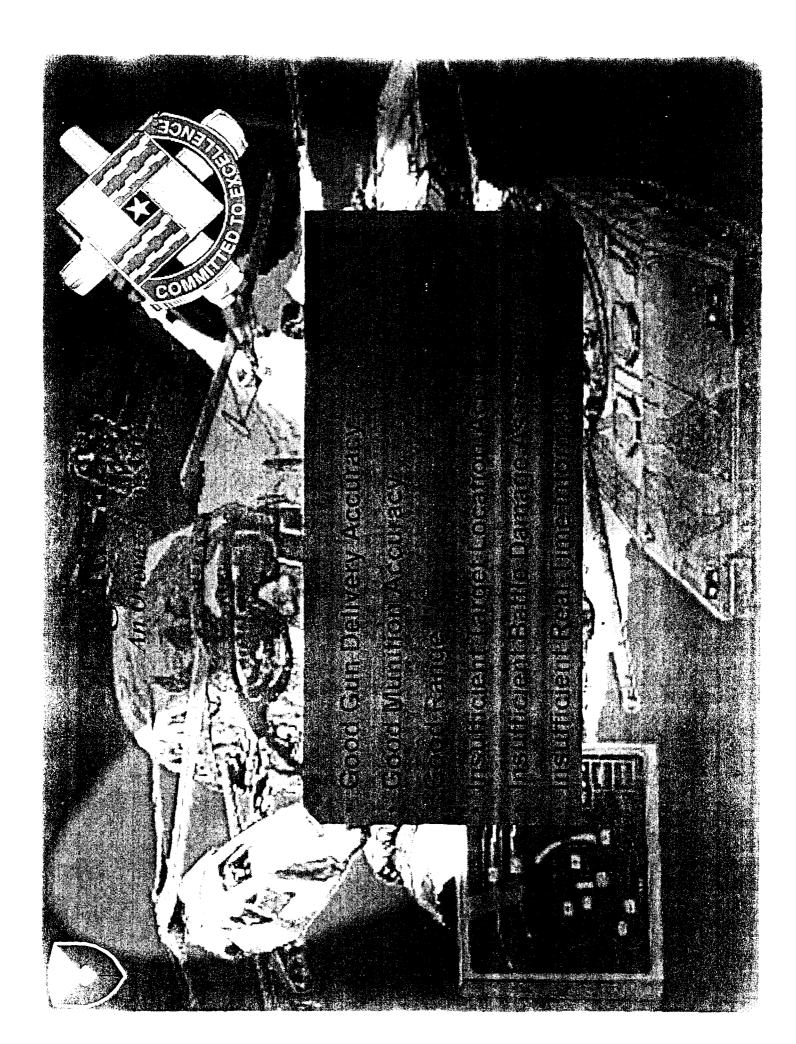














OuickLook STO

An Airborne Targeting Sensor Platform



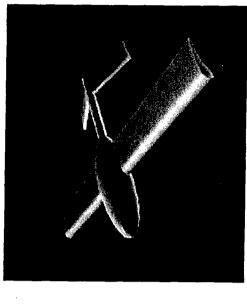
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> Objective: Develop and demonstrate a Brigade level fire support target sensor asset to improve the Brigade commanders capability for first round effects on target. This is accomplished by reducing target location error (TLE) and enhancing battle damage assessment (BDA) capabilities.

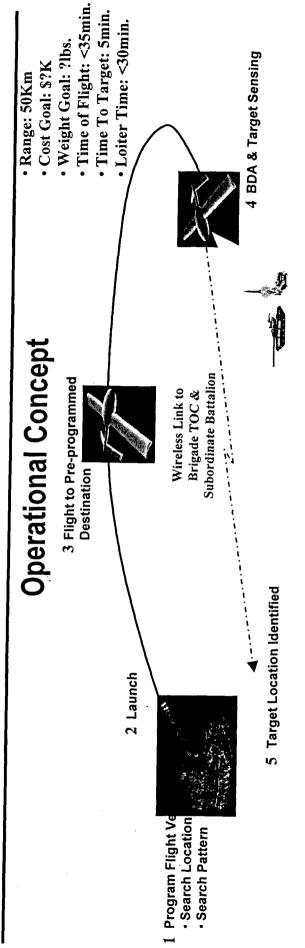
Justification: Provides Brigade commander with real time target imagery, coordinates, and BDA. Enables early entry forces to deploy w/organic targeting asset which provides for increased accuracy of existing & future artillery

USEL/PM: US Army Field Artillery School, Fort Sill

Director, Field Artillery DCD



Howitzer Launched Targeting System





AMC

Operational Scenario

Human Detection or Queued System



TACOM-ARDEC

> information to Brigade 3 QuickLook targeting TOC & Below

> > QuickLook

6 QuickLook provides BDA

GPS Satellite information to (provides GPS QuickLook)

2 Fire QuickLook

Paladin /

Crusader

Fire Projectile

M982

DPICM, or SADARM)

M982 Projectile Delivers Payload (HE,

Brigade TOC

Integrate, prioritize, and disseminate data using

AFATDS

Also Provide Adjust Fire for Conventional Rounds

Information from above

Brigade



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Applications in Weapon Surety and Inertial Sensing Micro Electro Mechanical System (MEMS)



James J. Allen, Ph.D., P.E.

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email: jjallen@sandia.gov

For additional information please see our website: http://www.mdl.sandia.gov/micromachine

Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Sandia is a multi-program laboratory operated by contract DE-AC04-94AL85000.



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Outline

- Introduction to Microsystems
- National Security Sector need drive technology development at Sandia
- MEMS Fabrication Technologies
- MEMS Applications: Microactuators
- Weapon Surety Components
- MEMS Applications: Microsensors
- Inertial Sensors
- MicroNavigators
- DOD/DOE MOU for MEMS Inertial Sensors



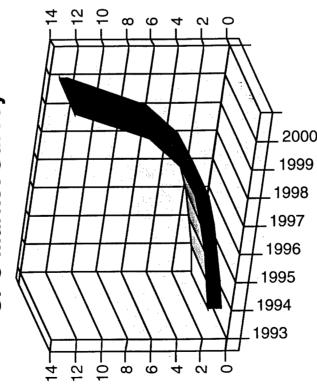
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Market Study Projects Year 2000 MEMS Sales

SPC Market Survey



Sales (Billion)

Medical Pressure Sensors

Existing and Anticipated Market Areas:

- Automotive Pressure Sensors
- **Smart Tires**
- Airbag Accelerometers
- **ABS Sensors**
- **Auto Navigation Gyros**
- **Smart Munitions**
 - **Pacemakers**
- **Machine Monitoring**
- Machine Control
- Industrial Valves Infusion Pumps
- Fluid Meters
- Ink-Jet Printers
- Optical Switches

These numbers could be dramatically impacted by new, unanticipated

applications.

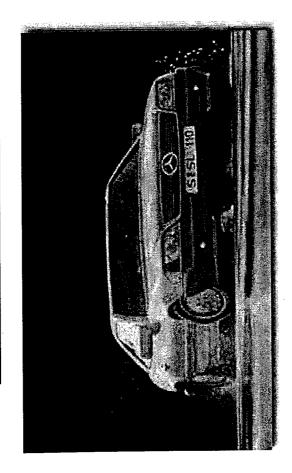




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Mercedes Benz Offers Electronic Stability Program on High End Cars





- System is Expensive
- **Board Inertial Sensors** System Includes On
- Dominates System Cost Cost of Inertial Sensors

further improve handling safety and ride comfort. One stage also become available for other S-class and SLrepresents a new milestone in the field of handling on its path. Within the physical limits, it counteracts swerving caused by black ice or wet surfaces. ESP is skidding while cornering and keeps the car safely Stability Program (ESP) which has been standard on developed intelligent traction control systems which always ready for action and also improves handling the S 600 coupé since April 1995 and will at a later of the most important innovations is the Electronic safety. By selectively activating the front and/or Acceleration skid control (ASR) is integrated into both wrong reactions on the part of the driver and class models. The Electronic Stability Program rear brakes, the system reduces the danger of "For the S-class, Mercedes-Benz engineers have safety when braking, accelerating and coasting.

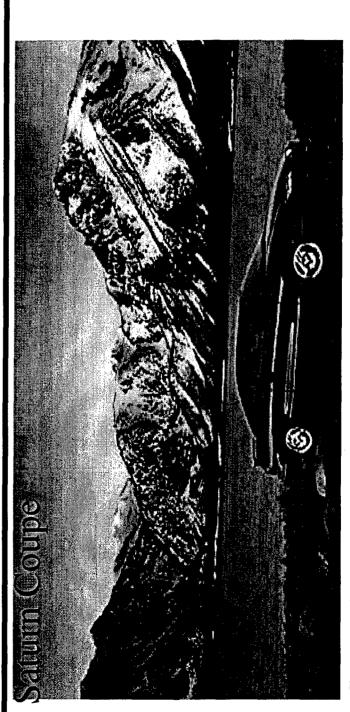


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Most of Us Don't Own a Mercedes S Class Automobile

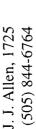


- The Saturn (and most new cars) have ABS.
- They do not have Electronic Stability.
- Cost of Inertial Sensor prevents access to this important safety feature to mainstream cars.
- Inertial Sensor cost must be < \$5.00 to be incorporated into mainstream



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MEMS Fabrication Technologies



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Categories of Micromachining Technologies

Bulk Micromachining

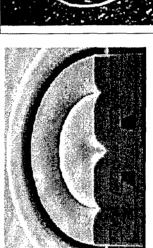
 Parts are formed out of the single-crystal silicon substrate by either wet chemical etching or dry etching

Surface Micromachining

 Parts are formed by depositing, patterning, and etching thin films of mechanical polysilicon and sacrificial oxide

Mold Micromachining

 Parts are formed by fabricating a mold—either in a polymer film (e.g., LIGA) or in the silicon substrate itself

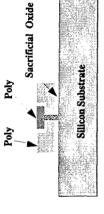


Wet etched cavity

Silicon Substrate

Dry etched pattern







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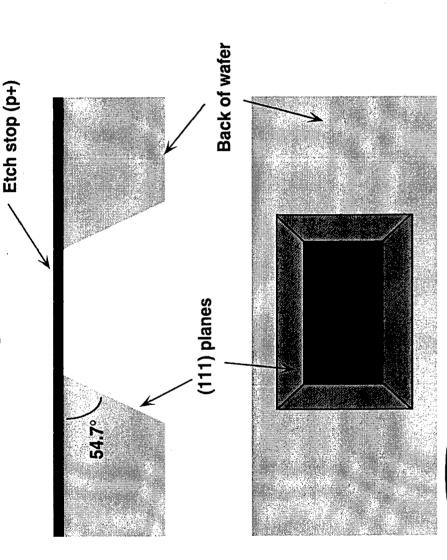


Silicon Substrate



Bulk Micromachining

- Key concept: Mechanical part is formed out of the substrate material
- Example: Bulk-micromachined pressure sensor etched w/KOH or EDP

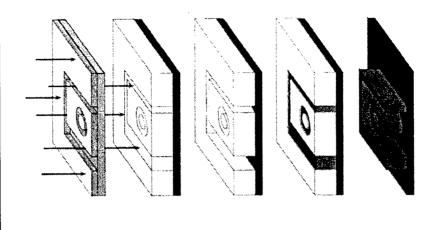




Mold Micromachining: LIGA Processing Steps



- X-rays from a synchrotron are incident on a mask pattered with high Z absorbers.
- X-rays are used to expose a pattern in PMMA, normally supported on a metallized substrate.
- The PMMA is chemically developed create a high aspect ratio, parallel wall mold.
- A metal or alloy is electroplated in the PMMA mold to create a metal micropart.
- dimensional metal micropart. This micropart can be separated from the base plate if desired. The PMMA is dissolved leaving a three



* PMMA - polymethylmethacrylate



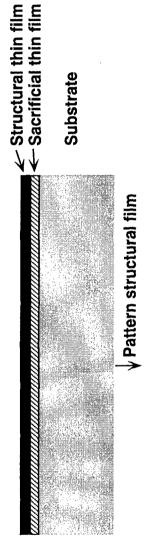
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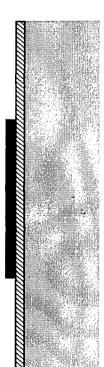
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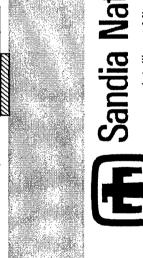


Surface Micromachining

- Key Concepts:
- Mechanical part is formed out of deposited thin films
- Need one structural and one sacrificial material
- Example: Single-level mechanical structure with unpatterned sacrificial layer







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Materials for Surface Micromachining

- Material system requirements:
- Structural film must have desirable mechanical desirable and electrical properties (low stress, conductivity, etc.) - Polysilicon
 - conditions and etch readily in an etchant that doesn't attack the Sacrificial film must be stable under structural film deposition mechanical film or the substrate - Silicon Dioxide
- Both films must be compatible with fabrication environment (generally silicon IC fab)
- SUMMIT Process:
- Structural Polysilicon
- Sacrificial Silicon Dioxide
- Electrical Isolation Silicon Nitride
- Substrate Single Crystal Silicon





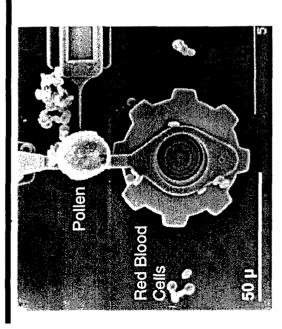
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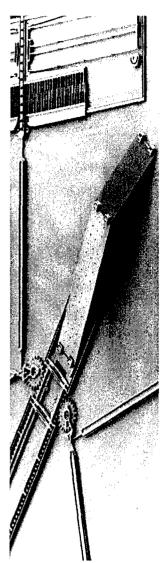




Merits of Surface Micromachining Technology



- Complex Miniaturized Mechanical Systems With Micron Feature Sizes
- Batch Fabricated With No Assembly Required
- Integrable with Silicon Microelectronics
- **Technology Exploits Microelectronics** Infrastructure





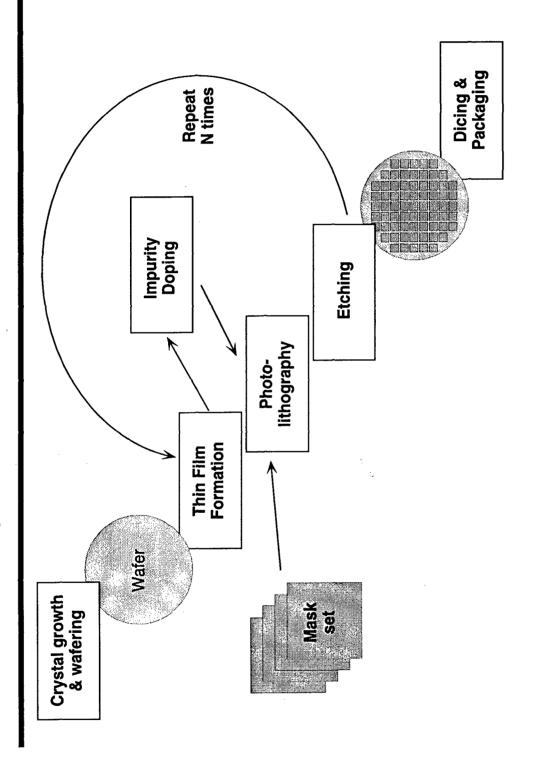
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Major Processing Steps in Electronic Integrated Circuit Fabrication







Sandia's Four-Level Surface Micromachining Technology Enables Useful MEMS Actuation



•Double-Level Technology

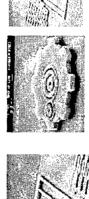
- Simple actuators (comb drives)
- Many sensors

Triple-Level **Technology**

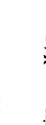
 Moving Parts (e.g., gears)

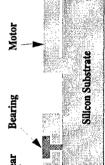
•Four-Level Technology

- Mechanical actuation of moving parts
- eg. SUMMiT Process









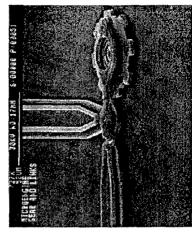
Electrostatic Micromotor

Motor

Polysilicon Level #1

Polysilicon Level #1

Silicon Substrate





Polysilicon Level #1
 Polysilicon Level #2
 Polysilicon Level #3

Th) Sandia National Laboratories

Intelligent Micromachine Technology Department





Sandia Infrastructure for Technology Development

The MicroElectronics Development Laboratory:

33,000 sq. ft. Class 1 Clean Room

State-of-the-Art Equipment Set

Sub-Micron, High Density CMOS

Flexible Configuration





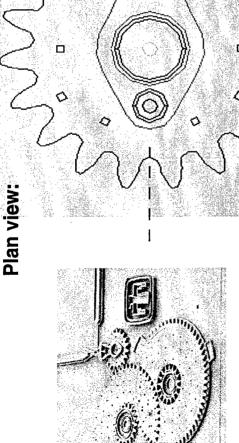
(Sandia National Laboratories

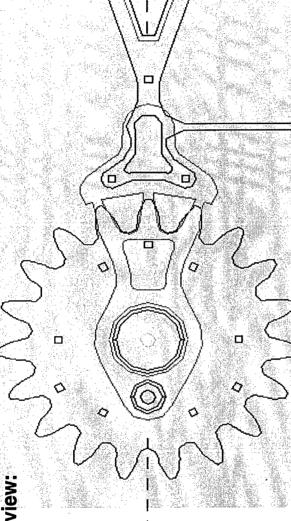
Intelligent Micromachine Technology Department



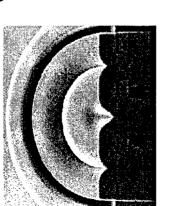


SUMMIT Process





Cross-section:

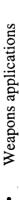




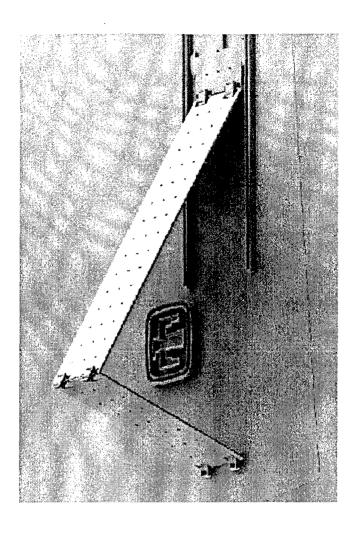
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MEMS Applications: **Microactuators**



- Safeing mechanisms
- Arming, fuzing, and firing mechanisms
- Biomedical and microchemlab applications
- Surgical instruments
- Sample manipulation
- Display/Communications
- Rotating and/or tilting mirrors
- Active alignment/packaging
- Mechanical shutters
- Automotive/Industrial
- Fuel Nozzles
- Microassembly
- Consumer electronics
- Ink-jet nozzles
 - Drive Heads
- And many more...





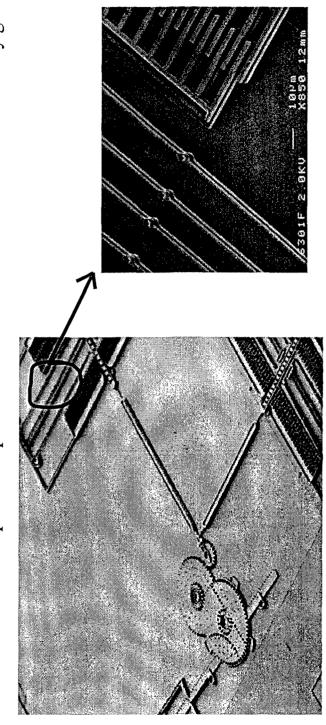
3 Sandia National Laboratories

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Sandia Microengine

- Two orthogonal linear drives linked to a rotary gear output.
- Rotating gear output allows unlimited movement.
- Linear actuation mechanism decoupled from the rotary gear output
- Enables independent optimization of the drive elements and the rotary gear output.





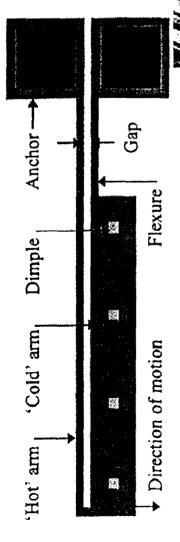
3 Sandia National Laboratories

Intelligent Micromachine Technology Department

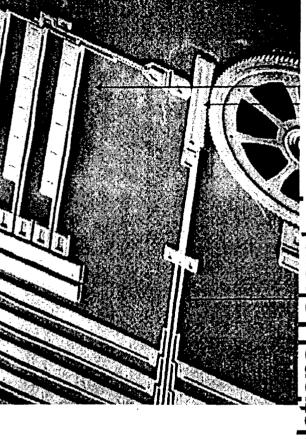
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Thermal Actuators (SM)



Ref.: Comtois and Bright, 1996 Solid-State Sensor and Actuator Workshop, June, Hilton Head Is., SC, pp. 174-177. (Air Force Institute of Technology)

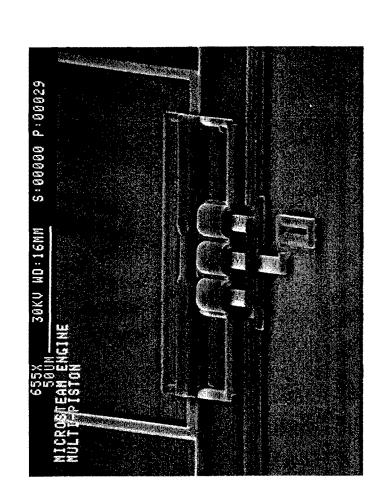


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Intelligent Micromachine Technology Department



SEM Microsteam Engine (SM)



Construction Material: Piston and Spring - 2 µm Thick Polysilicon Cover - 1 µm Thick Polysilicon

Piston Width: 6 µm



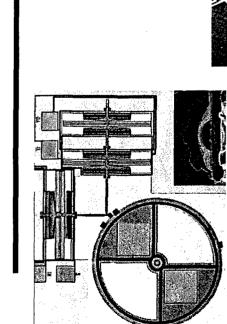
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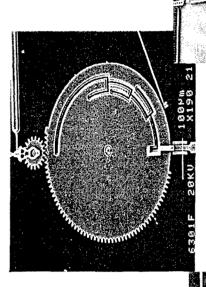
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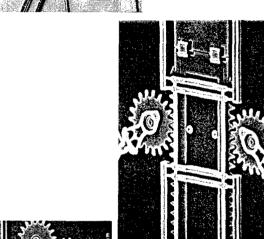
(505) 844-6764 J. J. Allen, 1725

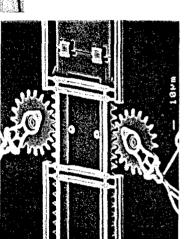


Technology Development For Micromachined Surety Components











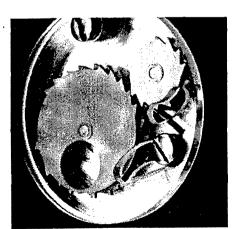
Intelligent Micromachine Technology Department



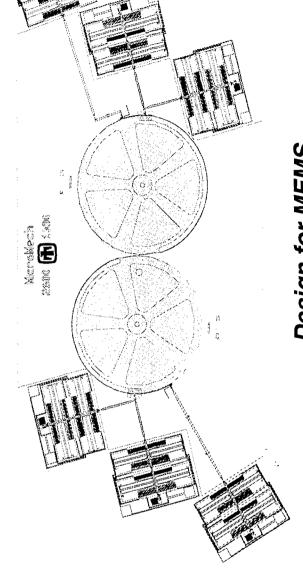
J. J. Allen, 1725 (505) 844-6764



Surety Components



Detonator Surety The Present Device



CounterMeshing Gear Design for MEMS Discriminator



Sandia National Laboratories

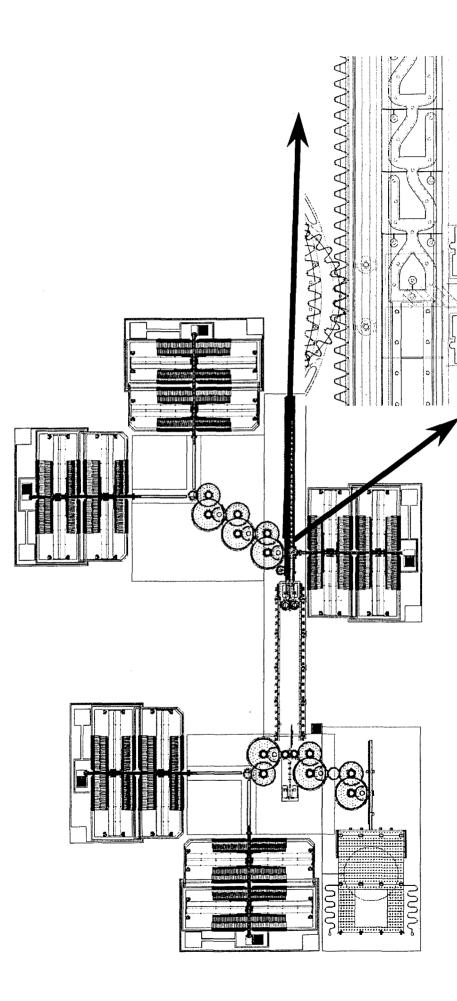
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066

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24 Bit Linear Maze/Mirror





Intelligent Micromachine Technology Department

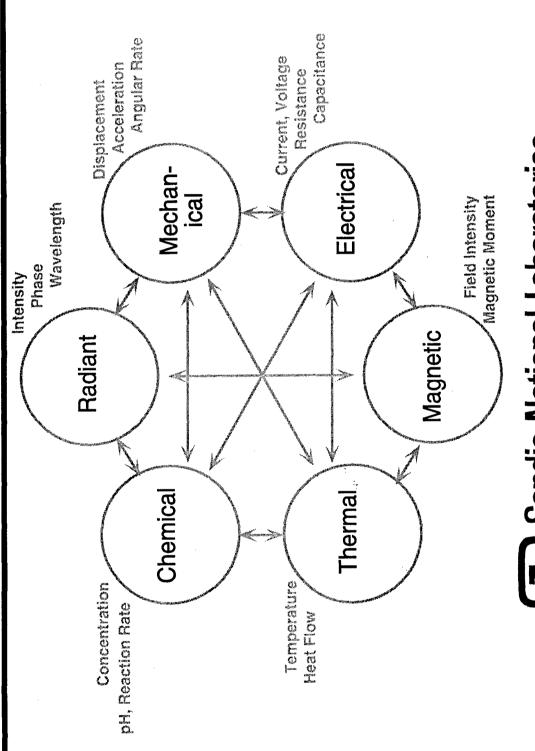


J. J. Allen, 1725 (505) 844-6764

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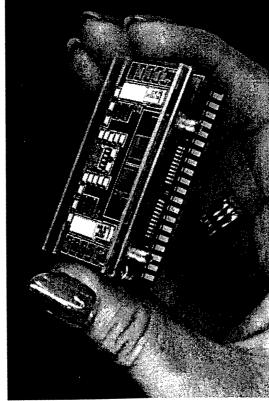
MEMS Applications: Microsensors



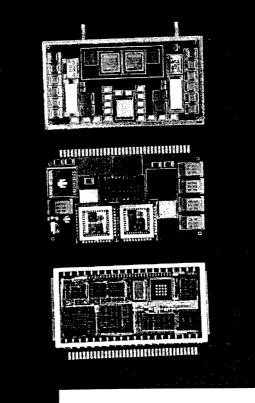


MicroNavigator





- The goal is to develop an integrated GPS/INS MicroNavigator.
- Currently developing MEMS Inertial Sensors for the MicroNavigator.



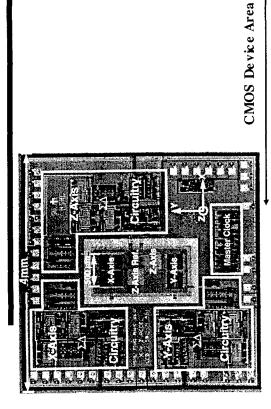


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Sandia's Modular Approach to Integration: Innovative and Manufacturable





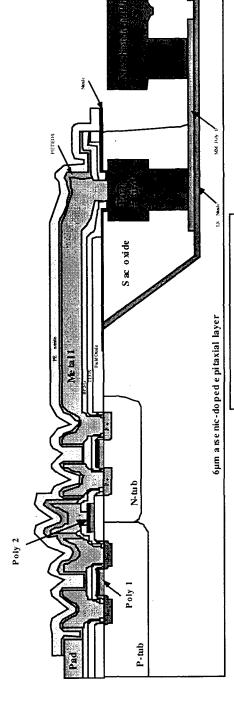
Trench Integration:

- Lower Cost
- Smaller Size
- Greater Sensitivity
- High Levels of Compatibility

Award

Traditional Integration Strategies Winner Overcomes Limitations of

Micromechanical Device Area





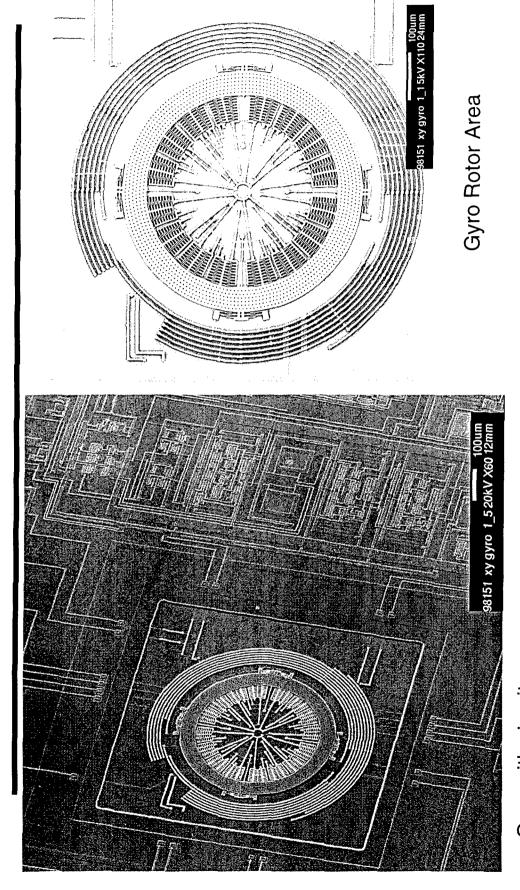
Th Sandia National Laboratories

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X-Y Axis Vibrating Gyro



Gyro with circuitry



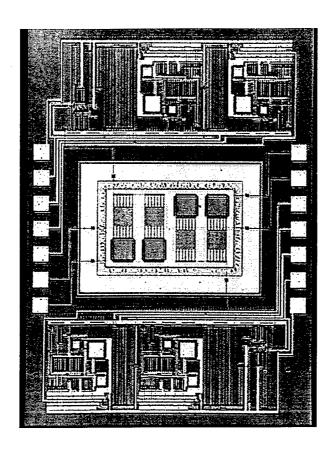
J. J. Allen, 1725 (505) 844-6764



Sandia National Laboratories Intelligent Micromachine Technology Department

Hi-G Accelerometer for Fuzing Applications

- 50 kG Accelerometer
- 1st Resonant Mode > 100 kHz

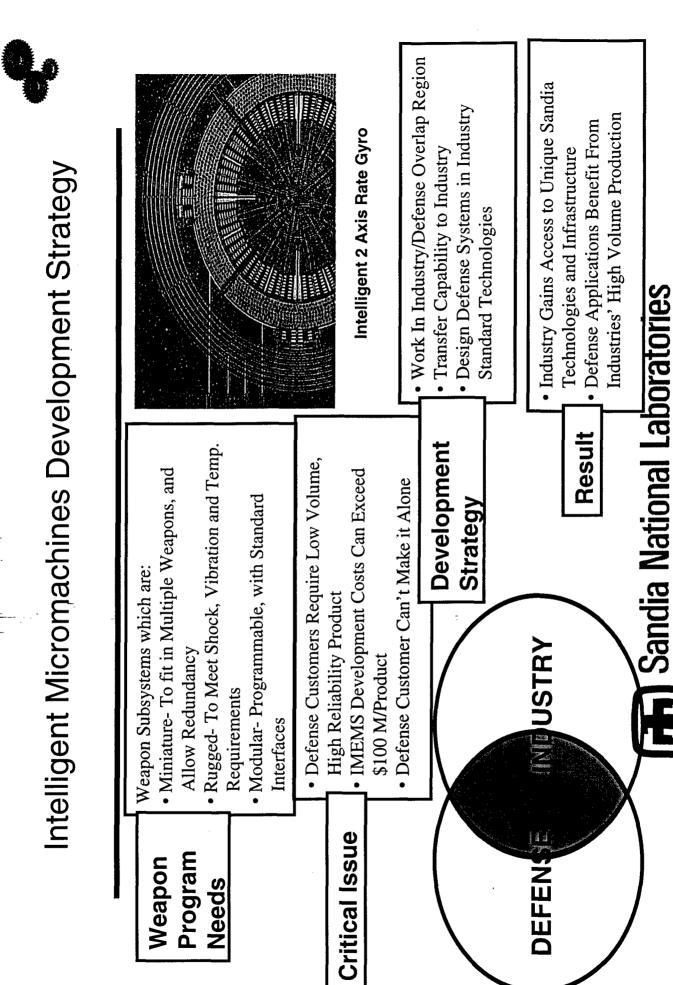




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Needs

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GPS for Munitions

Bryan Wesner

June 1998

Government Systems Division GPS for Munitions



Rockwell Collins





Missile & Munition Overview

PGM-GRAM Roadmap

Artillery Applications/Programs/Status

Low Cost Competent Munition

Competent Munition Technology Demonstration

ERGM Demonstration

Competent Munition ATD

Technology Focus

Summary

Government Systems Division GPS for Munitions

Rockwell Collins



Introduction

Historically GPS has provided guidance for High Value Missile platforms

enhancement for all classes of Missiles **Technology advances have made GPS a** viable means of providing accuracy and Munitions

Government Systems Division GPS for Munitions

Rockwell Collins





Missile & Munition Overview

Rockwell Collins is the leading producer of GPS receivers for Munitions

CMATD (5" Artillery)

LRAS3 (Attitude system)

ATACMS (Missile/Launcher)

JDAM (2000 lb. bomb)

CMTD (155mm Artillery)

SLAM-ER

JASSM

SLAM

ERGM Demo

AGM-130

TLAM Block III

GPS to meet wide range of armament needs

All classes of competent munitions needs met by GPS ie... Missiles, Bombs, Rockets, Artillery and Mortars Rockwell Collins





Missile & Munition Overview

Precision Guided Munitions (PGM) products have unique requirements

 Extreme environments, restricted size, jamming, acquisition and navigation performance

common Collins GPS technology components **Products for Munitions programs utilize**

- Custom GPS signal processing ASICs
- Advanced P/Y GPS Software functionality
- **Historically PGM applications required custom** products

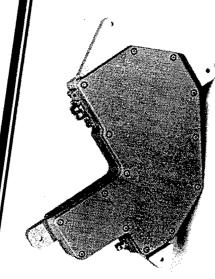
Government Systems Division GPS for Munitions

Rockwell Collins

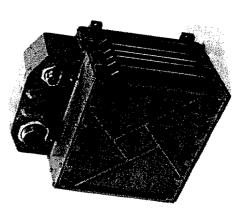


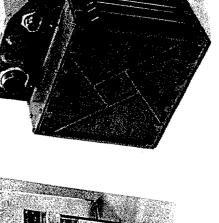
Rockwell GPS

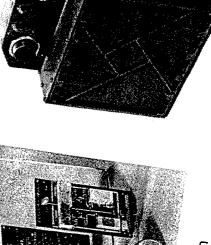
Missile & Munition Overview



Products customized by each application













Missile & Munition Overview

Reducing size and increasing capability & application to all classes of competent performance of P/Y GPS is expanding **munitions**

Two major application types identified:

- Precision Guided Munition
- > Missiles, Rockets, and Bombs
- Competent Artillery and Mortars
- Army 155mm and Navy 5"
- > Mortars

Rockwell

Government Systems Division GPS for Munitions



Missile & Munition Overview

GPS based solutions for high-g, gun launched competent munitions are maturing key technologies

- GPS ASIC integration & High density interconnect
- Robust oscillator solutions

PGM-GRAM provides means of reducing development and integration costs

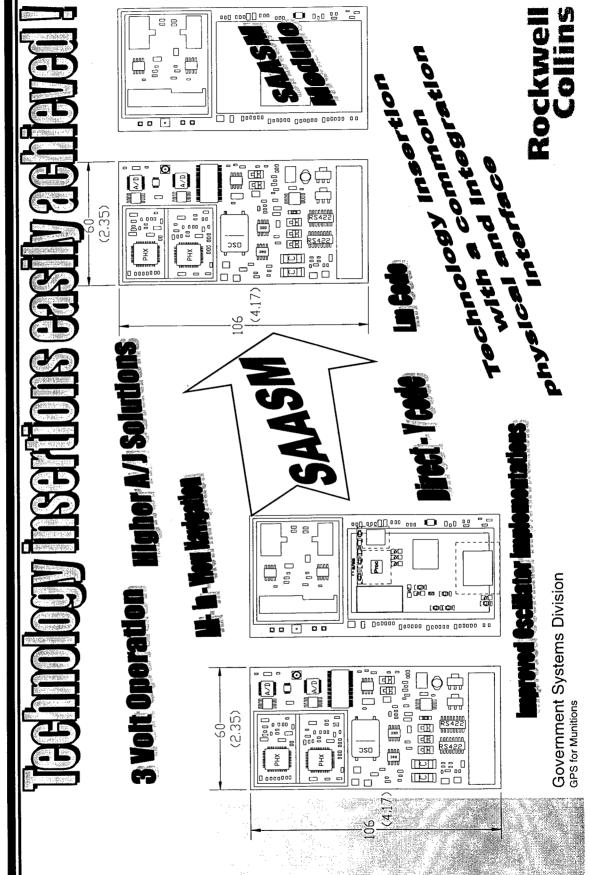
(Precision Guided Munition - GPS Receiver Application Module)

- > Open architecture interface standard
- Electrical & Interface Messages
- Common interfaces allow insertion of technology updates without platform re- integration



Bockwell GPS

PGM-GRAM Roadmap



PGM-GRAM Roadmap

Status

- Development of miniaturized PGM-GRAM underway
- ➤ GRAM interface and form factor
- > PPS-SM product supports customer integration
- Units available 1Q CY '99
- SAASM insertion planned as follow-on technology insertion
- ➤ Maintains GRAM backward compatibility
- > Provides reduced logistics burden with Black Key capability
- ➤Integration units available 4Q CY '99





Why Use GPS in an Artillery Shell?

Fielded rounds are unguided

Smart fuzing utilized for increased effectiveness

. Weapon Range Is Increasing

Improved Accuracy a Necessity for Long Range

- Less Munitions required per Engagement
- Reduces Mission Time
- Allows for More Missions per Battlefield Day
- Lower Demand and Cost on Logistic Chain
- Increases Survivability: "Shoot and Scoot"
- Reduces Collateral Damage

Rockwell





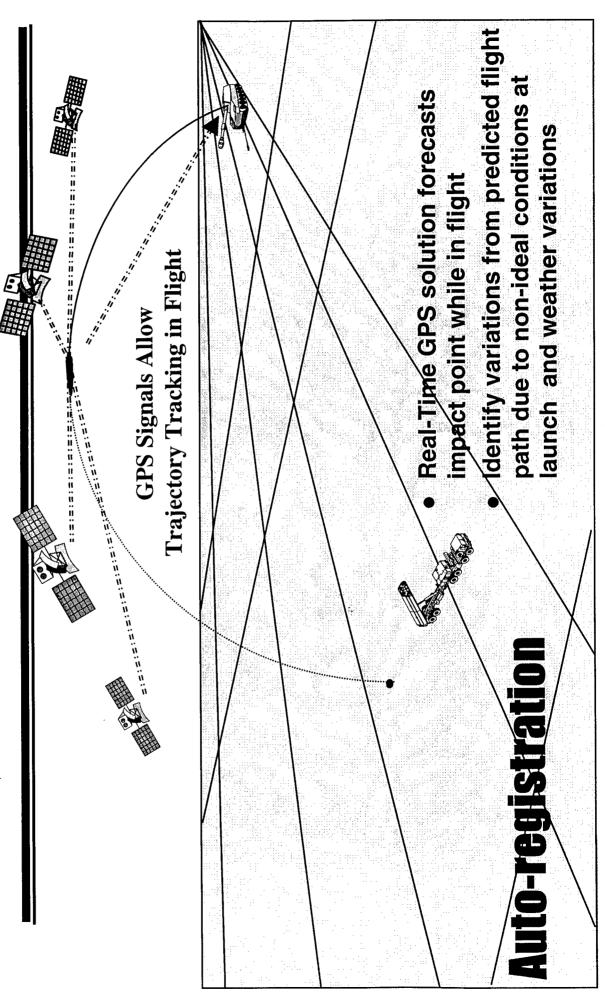
Competent Artillery Approaches

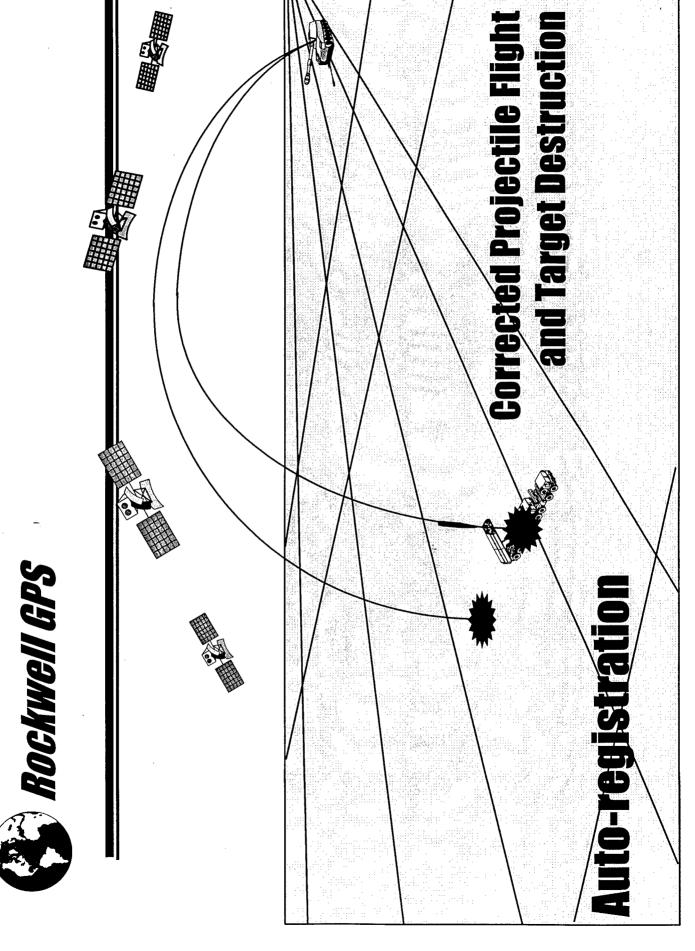
Collins is supporting three different approaches to Competent Munitions

- Auto-registration
- > 2 3X accuracy improvement over 20 to 50 km
- Low Cost Competent Munition (LCCM)
- Range only 1-D Correction
- 2.5 6X accuracy improvement for 20 to 50+ km
- Competent Munition Technology Demonstration (CMTD)
- Fully guided 2-D Correction
- > 4 15+X accuracy improvement for 30 to 100 km
- Extended Range Guided Muniton (ERGM) Demo
- Competent Munition ATD (CMATD)











Low Cost Competent Munition Program

PURPOSE

- Compute trajectory of first round fired
- GPS Autoregistration Fuze (GARF)
- RF repeater on shell rebroadcasts GPS signals
- > Ground Based Receiver (GBR) completes GPS processing
- Calculate correction and fire for effect

Status

- Development of the GPS system is complete
- All Fuze and Ground receiver components delivered
- Test firings completed May 98 @ Yuma
- Real-Time GPS processing unsuccessful
- Post flight data analysis ongoing

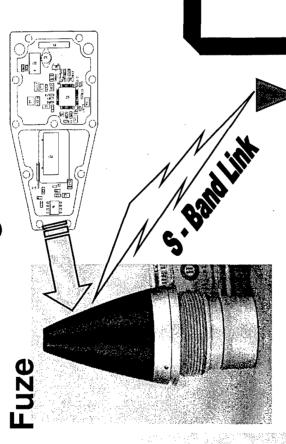






Low Cost Competent Munition Program

GPS AutoRegistration



S to L band

MPE 1.12

Translators

Receivers

GPS All-in-View

Ground Based Receiver

P(V) Differential

Base Stadion

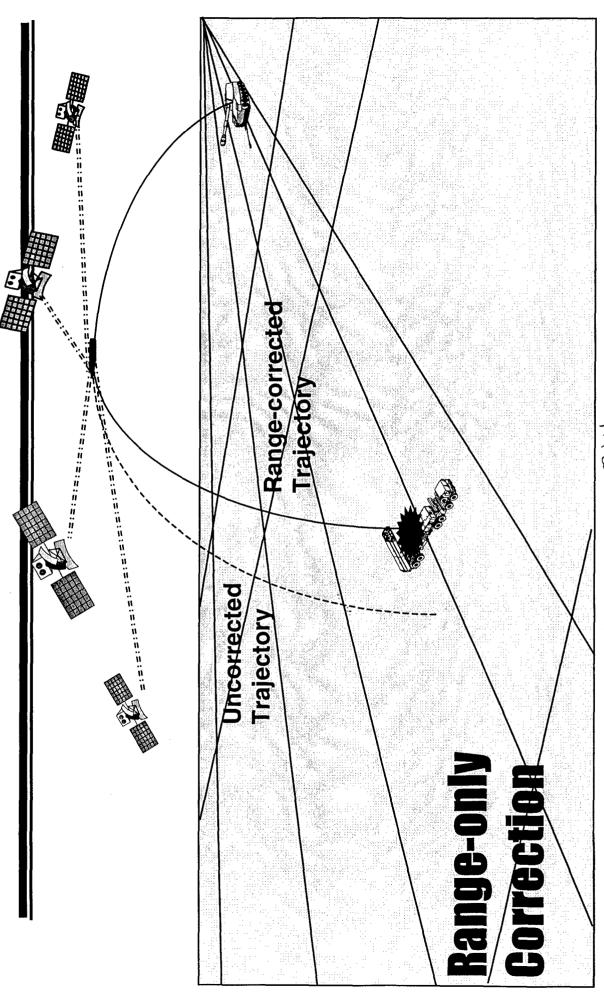
Application

Computer

Government Systems Division GPS for Munitions

Rockwell Collins







Competent Munition Technology Demonstration Program

Program Description

- demonstrating GPS based 1D corrected projectile Rockwell Collins, BAe Royal Ordnance (RO) and Thomson-Thorn Missile Electronics (TME) jointly
- Collins providing:
- ¬ GPS receiver
- > Solid state data recorder
- Antenna assembly
- Hosting (RO) Course Correction algorithms on GPS processor
- RO providing 1D drag break technology
- TME Systems Integrator







Competent Munition Technology Demonstration Program

Status

- Development of fuze based components
- GPS Receiver / Data Recorder
- Design complete, hardware layout in process
- Prototypes ready for integration Sept '98
- Collins development of fuze based antenna complete
- Provides more consistent gain pattern for fuze applications

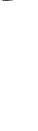
Test Plans

- Strength of design firings 4 Q CY '98 in UK
- ➤ Full functional firings 2-3 Q CY '99

Government Systems Division GPS for Munitions

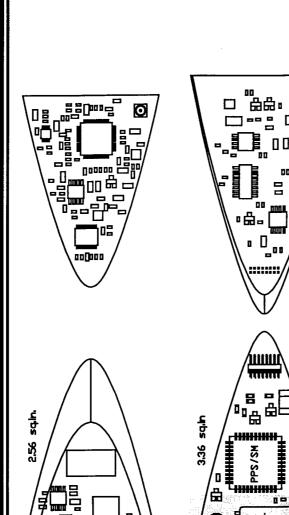


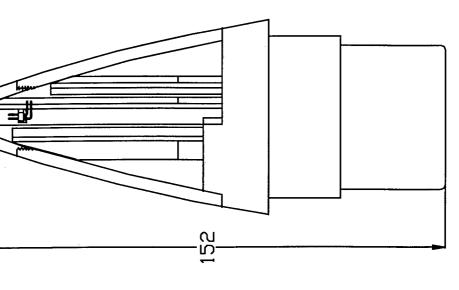
Rockwell Collins



Rockwell GPS

Competent Munition Technology Demonstration Program







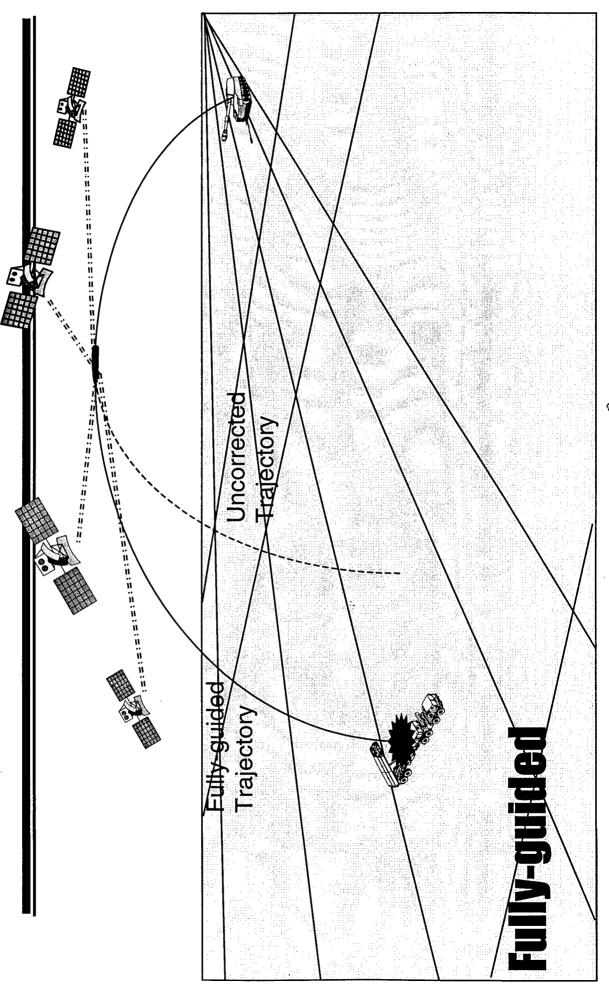




Government Systems Division GPS for Munitions

2.34 sq.ln.







ERGM Demonstration

Program

Extended Range Guided Munition Demo

- Technology demonstration of a GPS/INS guidance package for a rocket assisted Navy 5" Projectile
- Draper Laboratory (MEMS IMU and Integration)
- Rockwell Collins (Modified COTS P/Y GPS receiver)

Test Firing completed 11 April, 1997

- Yuma Proving Grounds
- 127 mm, (5") Navy Projectile
- Rocket assisted ~ 100 lb projectile
- Key test parameters
- > 6200 g Launch Setback Shock
- Altitude 40,000 ft, Range 18 nm (28.9 KM)
- Achieve 20 seconds to full GPS solution

Government Systems Division







ERGM DemonstrationProgram

Results:

- Acquired First SV on Y-Code at 9.8 Sec
- Developed a 4 SV solution on Y-Code at 13.9 Sec
- Tracked the selected SV's for entire 105 Sec flight

Conclusions:

Collins COTS receiver on a gunfired munition Successful GPS Acquisition and Track with a application







Competent Munition ATD Program

Competent Munition ATD

- Technology demonstration of a 13 cubic inch fuze based guidance package for a Navy 5" Projectile
- > Draper Laboratory (MEMS IMU and Integration)
- > Rockwell Collins (Fast Acquisition P/Y code GPS receiver)

Engineering development completed

- 3.1 cubic inch, All-In-View, Fast direct-Y code receiver
- Integration and test in process

Planned Test Firings

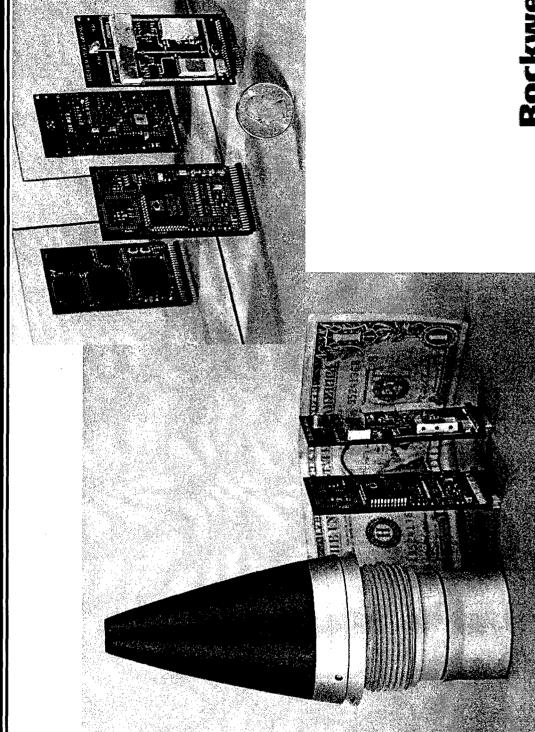
- Proof-of-design firing at Yuma Proving Grounds 4Q CY '98
- Full Performance Test Firings 1-2Q CY '99

Government Systems Division GPS for Munitions

Rockwell Collins



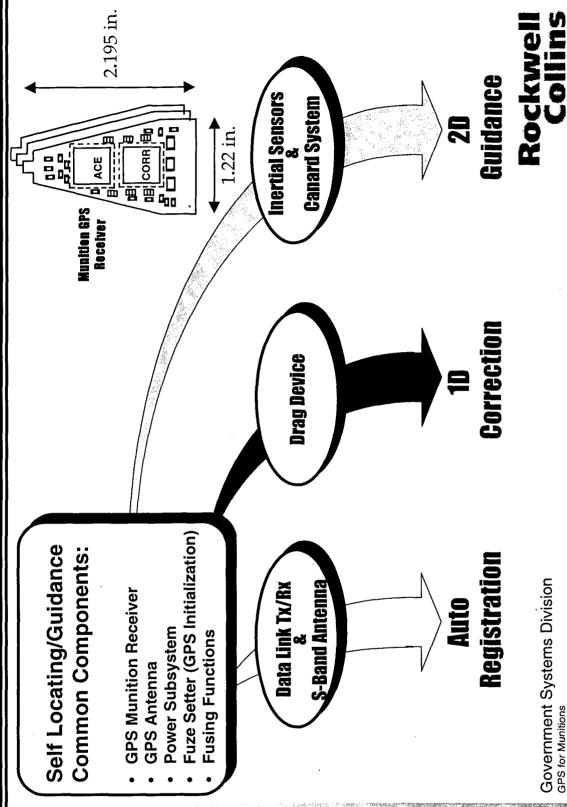
Competent MunitionATD Program



Government Systems Division GPS for Munitions

Rockwell Collins

all Munitions Applications **Common GPS Receiver for**





Technology Focus

Fuze Based GPS Technologies

Antenna

- Collins developed and tested prototype
- Consistent gain pattern improvement over patches

Oscillators

- > Over 200 Oscillators shock tested to > 10,000 g
- 9 different models from 6 vendors have been evaluated
- Candidate oscillator selected, additional robustness enhancements in process

Miniature High-g Receiver Technology

- > State-of-the-Art Chipscale packaging
- > Highly integrated 2-chip fast direct-Y code GPS solution

Rockwell

Government Systems Division GPS for Munitions





Technology Focus

Jamming

- Current Artillery GPS Receiver Acquisition Capability is >40 dB J/S
- > More Than Adequate for Demonstration Programs
- Adequate for Low Power Jammer Near Target scenarios

Tactical Environment Needs

- > High Power Jammers Near Target or Low Power Jammers Closer to Gun
- Rockwell Has Completed Thorough Analysis
- ★ NAVWAR enhancements for jamming robustness easily support mission needs for fielded artillery

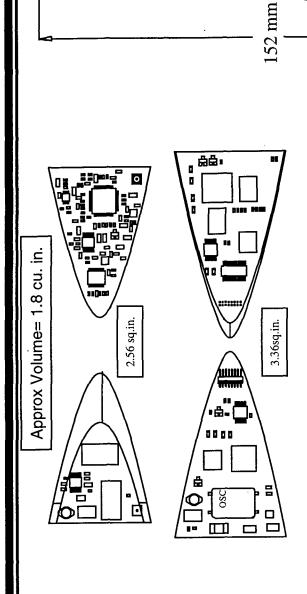
Government Systems Division aPS for Munitions







Fuze Based SAASM GPS



SAASM (Selective Availability/Anti-Spoofing Module)

- Accept and process unclassified Crypto Keys
- Eases Key Distribution Logistics Issues
- **Rockwell SAASM Status**
- SAASM Supplier First SAASM Production Program (CSEL)
- Chip integration plans support artillery applications





Government Systems Division GPS for Munitions





Future of GPS for Munitions

More resistance to jamming

Both acquisition and track

SAASM (Selective Availability/Anti-Spoofing **Module**)

Accept and process unclassified Crypto Keys

More system functionality in GPS processor

- Course Correction Algorithms
- Tightly coupled system Navigation solution
- Autopilot / Guidance

Smaller, Faster, Cheaper

Government Systems Division GPS for Munitions



C68



Summary

- Rockwell is committed to the GPS business
- **Our technology investments are evidence of our** continued commitment to be the P/Y GPS leader
- Our products span the user base for all Missile & **Munition applications**
- Artillery Shells
- Bombs
- Mortars
- Missiles
- Rockets

Bockwell provides GPS

System solutions for
Competent munitions with
technology, products, and
integration expertise

Rockwell Collins

Government Systems Division GPS for Munitions

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GPS Auto-Registration System

Gary Schlieckert

24 June 1998





Objectives of Auto-Registration

- Improve the effectiveness of artillery rounds in current inventory
- Increased firepower and survivability
- Reduced logistics burden
- Force structure compatibility
- Fuze module form factor per NATO standard
- No change to inductive fuze setter
- Minimum impact on platforms
- Fully automated and passive
- Low cost
- Supports the Army XXI thrust to:

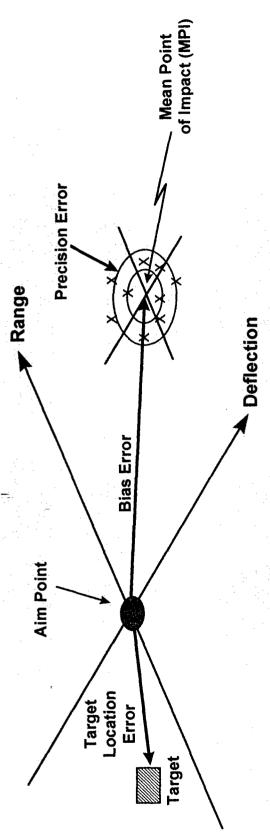
"Take the equipment in inventory today...and enhance them with information age technology." General Dennis J. Reimer, Chief of Staff, Army







Bias Errors at Extended Ranges Problem —



- Bias Error (MPI Error) Variation of the mean impact from the Aim Point
- Precision Error Variation of round impacts about the mean
- Target Location Error Variation of the Aim Point to the Target

Current Procedures

- Forward observers for estimating miss distances and communicating information back to shooter
- Increasingly hazardous for deeper attacks
- Patterned fires to assure coverage
- Consumes large number of rounds per mission







GPS Auto-Registration Approach

Translator Implementation

- Captures and re-transmits GPS signals to a Ground Based Receiver
- Translator electronics located in fuze module
- GPS receivers located at Ground Based Receiver process GPS signals to estimate projectile positions
- Advances in GPS receivers do not impact fuze inventory

Advantages of GPS System

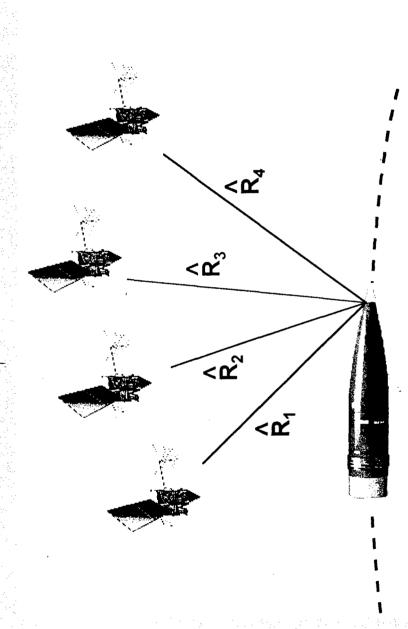
- Provides position data accuracy which is range independent
- Provides all-weather capability
- Leverages Army and Navy development activities on small, low cost GPS technology for projectiles







GPS Position Estimation



- Based on simultaneous measurement to four satellite positions
- Provides position of the capturing antenna on the projectile

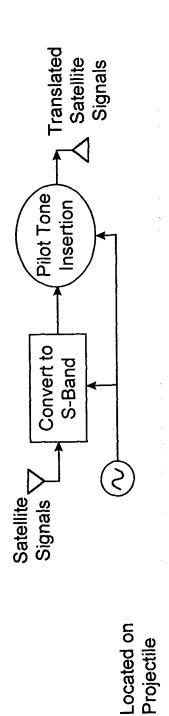






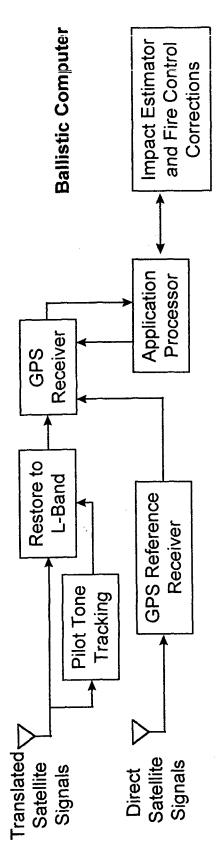
Translator System Block Diagram

GPS Auto-Registration Fuze Module



Located on Ground

Ground Based Receiver

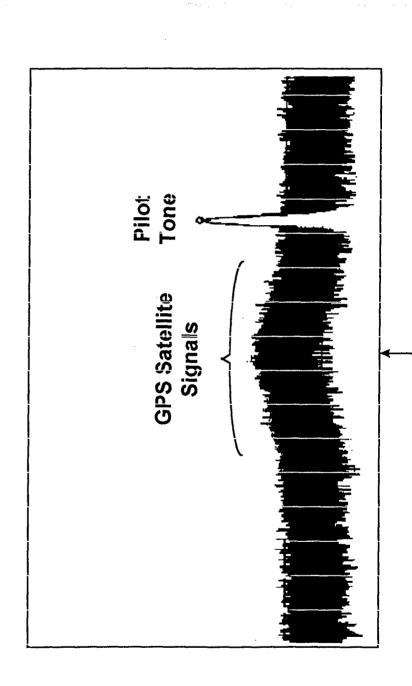








Franslated GPS Signal



Translated from Original 1.575 GHz 2.266 GHz

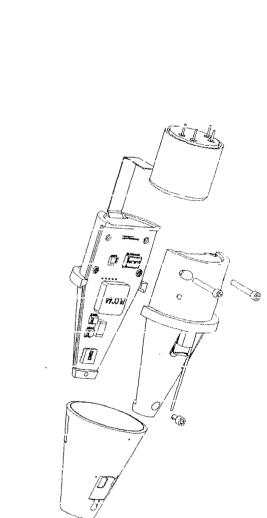


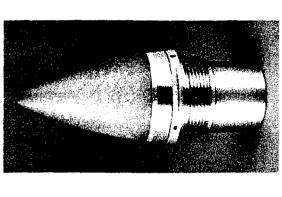




GPS Auto-Registration Fuze

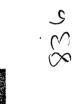
- L-Band to S-Band Frequency Translator
- Compatible with both GPS signal formats
- Downlink frequency selectable via inductive setting process
- Standard NATO Form Factor





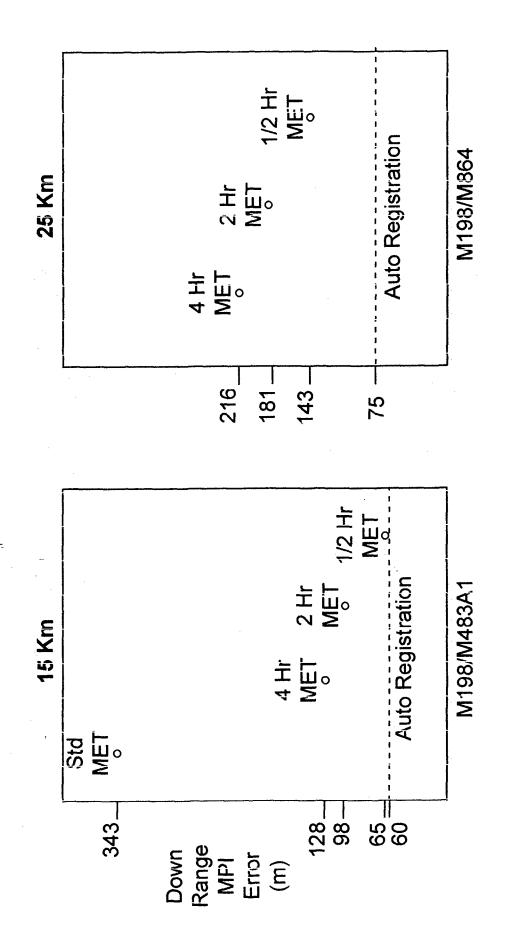






T102494.ppt_8 (author)

Projected Accuracy Improvements







1102494,ppt_9 (author)

Impact of Effectiveness

		Number of Rounds	Number of Rounds Required (F _c = 0.3)
Scenario	Range	Predicted Fire Without Auto-Registration	With Auto-Registration Corrections
M198 HowitzerStandard METM483A1 Projectile	15 Km	115	15
M198 Howitzer2 Hour METM549A1 Projectile	25 Km	78	27







Program Summary

Current Contract

- Alliant Techsystems developing system to demonstrate real time system function
- Cooperative development with ARDEC and ARL
- Demonstration in October, 1998

What Next

- Fuze module design merging fuzing and auto-registration functions
- Explore expanded uses of trajectory data in the Digital Battlefield







Payoff

- Increased effectiveness of current inventory projectiles at low cost
- Reduced logistics burden
- Increases survivability







 Ground Based Receiver Component Technology Provides Automated, Unobserved Accurate Registration Onboard GPS Translator Relays Signals to Ground Receiver GPS Translator Ballistic Computer Generates Corrections for Immediate Impact Point is Predicted & Compared to Aimpoint GPS Arrio-Registration System Operation Actual Trajectory is Calculated Transfer to Subsequent Fire



Army Research Laboratory

GPS-Counter Measures/Counter Counter Measures Techniques

Andrew Ladas June 24, 1998



Outline

Counter-Measures / Future Improvements Global Positioning System Basics Jammer Types/Threats Artillery Application Jamming Example

- System Improvements
- User specific techniques

Conclusions



Why All The Fuss?

GPS jammers are inexpensive and easy to fabricate from commercially available parts

greatest concern of the US military" - Rand Report "The proliferation of small wideband jammers is the on GPS, 1995

Independent Assessment, MIT/Lincoln Labs, 1996 "The vulnerability of GPS to jamming is principally a consequence of the GPS design and not the munition." - Naval Surface Fire Support

ナナン



GPS Receiver Basics

24 satellites in 1/2 geo-synchronous orbits (20,000 km)

Four satellite observations give position and time





Single frequency, L1

Provides handover to P(Y) code

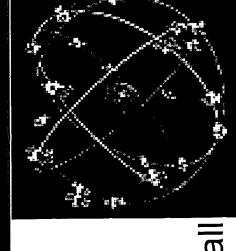
P(Y) code "precise" - authorized users only

Two frequencies L1/L2 (new frequency schemes under investigation)

Acquisition through C/A code handover, or direct

7 day long code, 10 MHz bandwidth

Requires accurate time and frequency information





GPS Receiver Basics (cont.)

Spread spectrum - spreads satellite vehicle (SV) signal

- $(-163 \text{ dBw}) = 0.00000000000000005 \text{ watt} (10^{-16})$
- Receiver correlates incoming signals with internal replica codes in frequency and time

Line-of-sight system

- Affected by terrain and overhead clutter
- Interference needs to be line-of-sight to be effective

anti-jam protection during acquisition and 54 dB of Typical P(Y) code receiver provides up to 26 dB of anti-jam protection in tracking mode



Jamming Example

$$J/S = 26$$
 dB acquisition $J/S = 53$ dB tracking

$$J = -163 + 26 = -137 \text{ dBw}$$

 $J = -163 + 53 = -110 \text{ dBw}$

Receiver in tracking mode in presence of 1,000 watt (30 dBw) jammer

Required Anti-jam	(jammer - J)	acquire	27 dB	35 dB	47 dB	. 67 dB
Require		track	0 dB	8 dB	20 dB	40 dB
Jammer Power	at distance	(30 dBw - attenuation)	-110 dBw	-102 dBw	-90 dBw	-70 dBw
Jammer	attenuation	at distance	140 dB	132 dB	120 dB	100 dB
Distance			100 miles(160 km)	40 miles(65 km)	10 miles(16 km)	1 mile(1.6 km)



Jammer Threats

Low Power

- small, light, short life easily deployed
- under \$1000
- ERP 1-10 watts



Mid Range

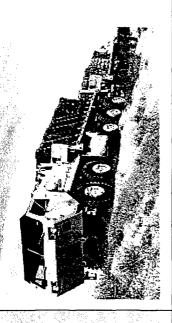
- transportable, vehicle deployed
 - generator power
 - under \$100,000
- ERP 100-1000 watts



High Power / High Value

- large, heavy, or airborne

 - \$1,000,000 and up ERP 10-100+ kwatts





Russian Jammer

Aviaconversia

GPS/GLONASS

Dual Frequency

Power: 4 watts

Range: untested

estimated up to 150 km Weight: 8-10 kg (without battery)

Cost: less than \$50,000





Artillery Application

Comparison of GPS P(Y) code signal denial for two cases Multiple jammers distributed in the impact area, system acquires GPS prior to experiencing jamming signal Target 40 km away, 120 sec time of flight 155-mm artillery firing guided munition

- Current typical receiver system
- various improvements (filtering, satellite link,etc.) Addition of 30dB jamming immunity through

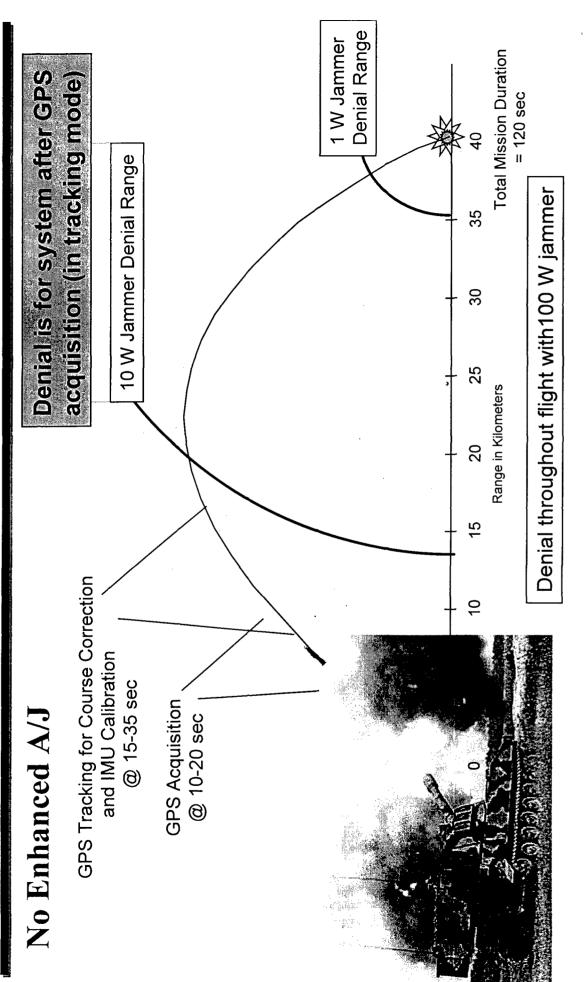


3-4 jammers around target 1W - 1kW



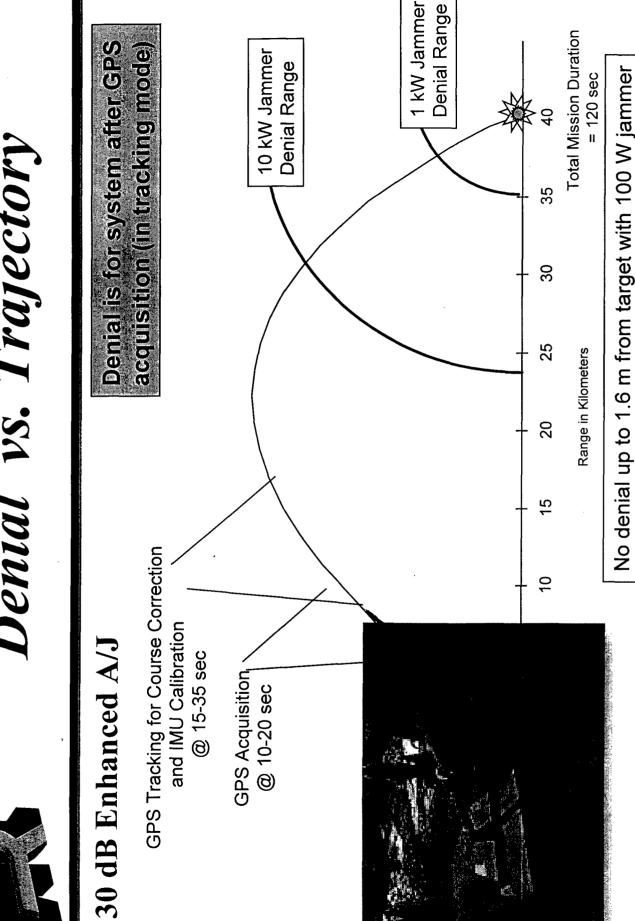


Denial vs. Trajectory





Denial vs. Trajectory







Corrective Action

Navigation Warfare - "Navwar"

... the ability of the US and allied forces to maximize the ensuring minimal impact on authorized civil users outside inherent operational capability of GPS within the Area of hostile use of satellite navigation against said forces and Responsibility (AOR) while simultaneously negating the the AOR."

\$14 billion spent since 1973

(ECCM) for receivers alone may cost several billion Improved electronic counter countermeasures dollars





System Improvements

Space Segment - changes to satellites (implementation FY02 & beyond)

- Increase output power
- New signal control
- New military/ civilian frequencies (L_m/L_c)
- Reuse current frequencies (L1/L2)
- Improved clocks; less drift
- Improved ephemeris
- Improve satellite reliability and autonomy

Navigation Control Segment

- Improved forecast prediction models for position and navigation
- Increase monitoring/communication sites



User Equipment Improvements

Adaptive temporal filters

- Counters narrow band jammers
- Jamming signal predictable over time

Spatial filtering

- Counters wideband jammers
- Multiple antennas to produce null in jammer direction
- Controlled Radiation Pattern Antenna (CERPA)
- Inherent null on artillery shell (when pointed at jammer) GRAM/SAASM (GPS Receiver Application Module / Selective

Availability Anti-Spoof Module)

- Ensure security, interoperability, and interchangeability
- Digital adaptive processing leading to software based systems



User Equipment Improvements

Inertial aiding

- Used during time of poor or absent GPS signals
- Requires calibration from receiver

Direct P(Y) code acquisition

- Can use encrypted L2 only
- Provides improvements against jamming and spoofing
- Requires knowledge of ephemerides and accurate time
- Improved oscillators/clocks, more correlators

Other improvements

- All-in-view processing (over-determined solution)
- Carrier phase tracking (improves accuracy)
- Signal augmentation Differential GPS
- **Pseudolites**





Conclusions

Small, low power jammers are inexpensive and easy to fabricate from commercially available parts

Proliferation of small wideband jammers is the most concern for the U.S. Military

space/satellite segment and user equipment Navwar efforts are ongoing to improve the

continuing Navwar efforts and improving anti-Force jammers to be large and expensive by jamming capabilities Large, high power and airborne jammers will be high priority targets

DeadEVe.

A Remote Controlled Stabilized Gun Mouni

First Burst on Target!



DeadEye

GENERAL DYNAMICS ARMAMENT SYSTEMS

828

6/29/98

DeadEye ... Supports Future Weapon System Imperative

compact, all electric weapon control and stabilization "In most Countries, the main emphasis in the future will be the development and production of more systems for armored vehicles." Janes, Armour and Artillery Upgrades 1995-1996

GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye .. Program Requirements

Develop a Remote-Controlled, Stabilized Gun Mount for Small Caliber Weapons

- **Gunner Survivability:** Place Gunner Under Armor
- System Accuracy: Decrease Dispersion Error and Improve Single Round & Burst Hit Probability (Stationary & Moving Platforms)
- Environmental: 24-hour, All Weather Capable
- System Survivability: 7.62mm, NBC, EMI/EMC Protection; Vulnerability Reduction Measures (VRM) Integral to Design

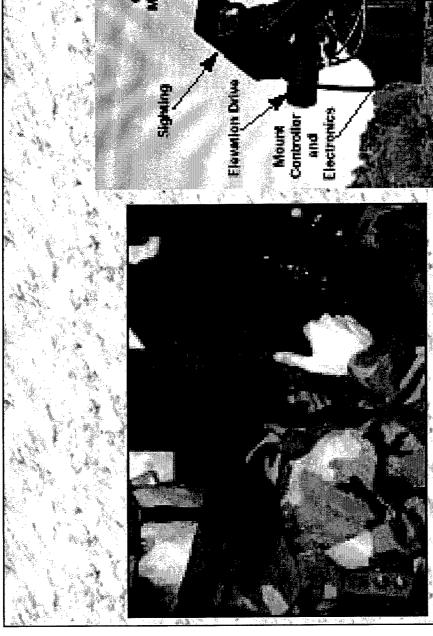
GENERAL DYNAMICS ARMAMENT SYSTEMS

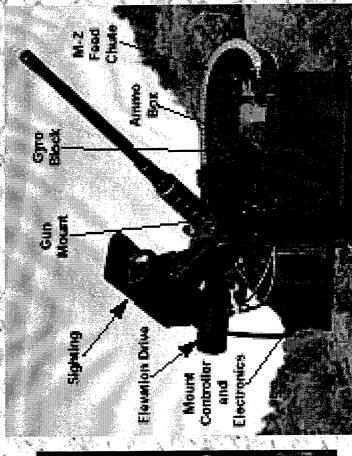
DeadEye ... Program Requirements

- **Deployable:** Interface with Existing Mounting Hardware; Install/Remove in Field Using on-Vehicle Tools
- User Friendly: Easy to Learn, Operate, and Maintain
- Supportable: Aggressive Duty Cycle; High MTBF; Low MTTR; Minimal Preventative Maintenance
- Adaptable / Expandable: Current and Future Weapon Systems
- Affordable: Under \$50K per Unit in Series Production

GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ... Engineering Prototype





Externally Mounted Components

Remote Control Unit

GENERAL DYNAMICS ARMAMENT SYSTEMS

6/29/98

DeadEye-

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DeadEye ... Engineering Prototype 1 Major Assemblies

◆ Gun Mount:

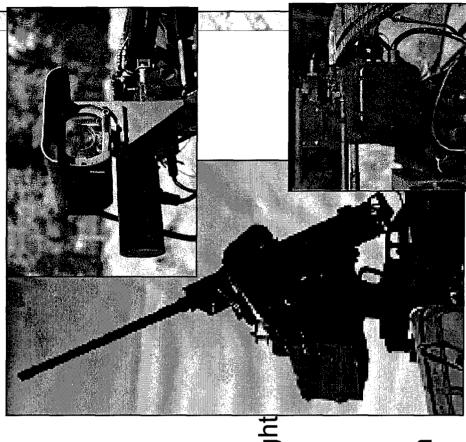
- · Cradle
- Upper & Lower Carriage
- Ammunition Box & Chute
- Firing Solenoid

· Sighting:

- 1.3 12X Color LCD Day Sight
- Generation III Night Sight

▶ Elevation Drive:

Harmonic Drive with Position
 Feedback & Gyro Box



GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye

DeadEye-

DeadEye ... Engineering Prototype 1 Major Assemblies

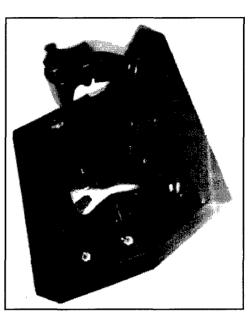
▶ Mount Controller:

Slip Ring, Azimuth Drive,
 Electronics, Position Feedback



♦ Remote Control Unit:

- Seven (7) Inch Diagonal Display
 & Two Handgrips with Video Output
- Reticle and Overlay Generation with Built-in Electronics



DYNAMICS ARMAMENT GENERAL

DeadEye ... System Characteristics

- Height
- Weight
- E-O Performance (NATO Target)

ammo)

Recognition: 2,300 meters

< 90 Kg (less weapon &

0.61 Meter (24 inches)

- Identification: 1,550 meters
- < 3.0 milliradians (on-themove)

Stabilization

Elevation

- -20 to +60 Degrees
- 2.0 to 57.0 Degrees per Sec
- 2.0 to 57.0 Degrees per Sec 360 Degrees Continuous

Azimuth

GENERAL DYNAMICS ARMAMENT SYSTEMS

6/29/98

DeadEye ... System Characteristics

Power

50 (nominal);150 (peak) 28VDC, Mil-Std-1275AT Watts

Remote Control Unit Screen

Color LCD

Video Output

NTSC (SMPTE 170M-1994)

Ready Ammunition Capacity

300 (M2HB); 144 (MK19) rounds

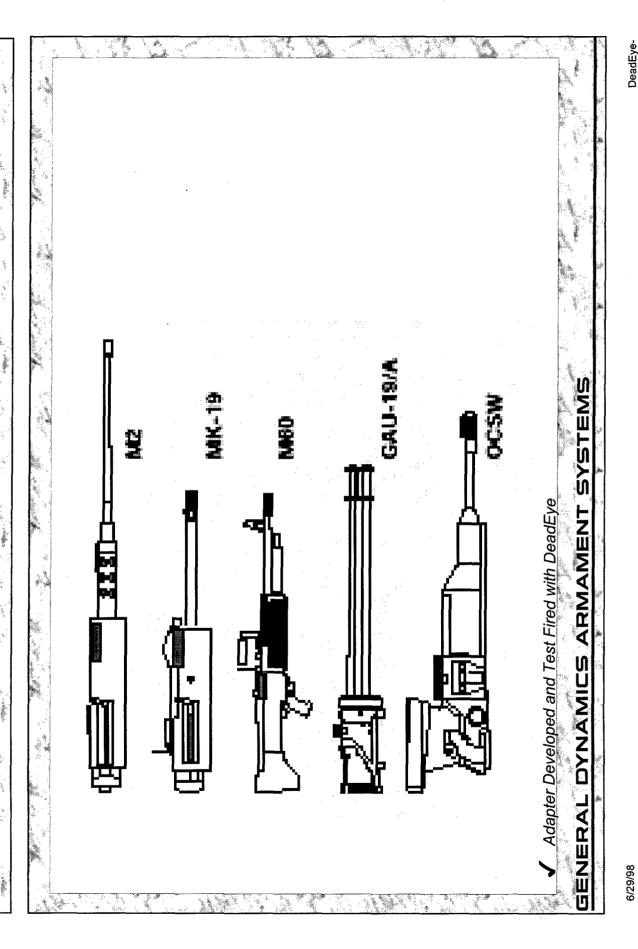
Environmental

MIL-STD-810E; -25 to +49 °C

SYSTEMS **DYNAMICS ARMAMENT** GENERAL

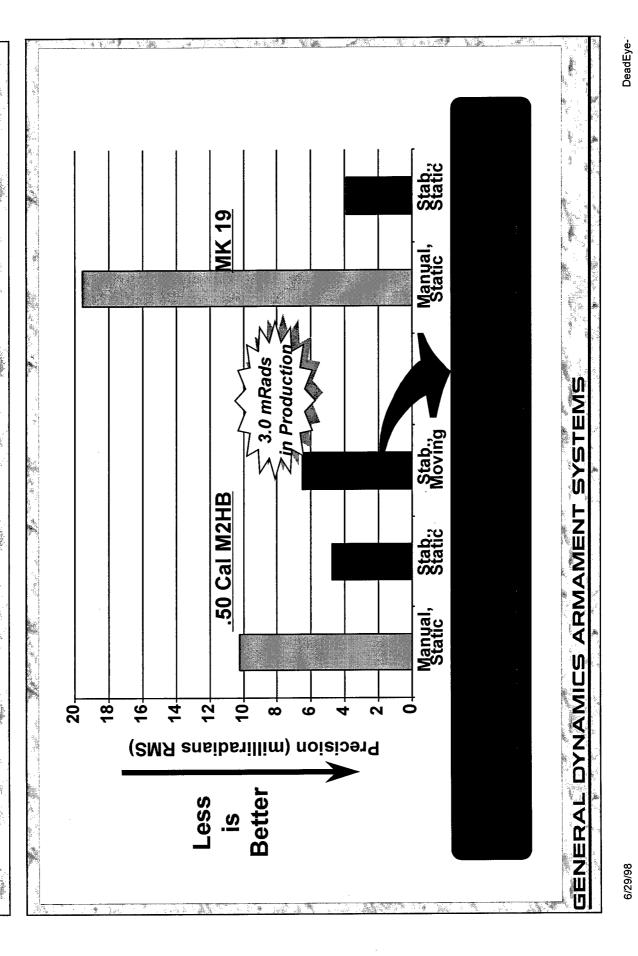
6/29/98

DeadEye ... Weapons Supported



DeadEye-

DeadEye ... Firing Precision Test Findings



DeadEye ... Summary



- Easy to Learn, Operate & Maintain Low Unit Cost High RAM-D Adaptable Stabilized
- Remote Operations
- All Weather, Day-Night Capable

- Full Manual Backup
- Supports Multiple Missions

GENERAL DYNAMICS ARMAMENT SYSTEMS

FIRE SUPPORT: ARMY XXI + & AAN STABILIZED SECONDARY ARMAMENTS

CLAWS

COMPACT LIGHTWEIGHT ARMORED WEAPON STATION

Dave Thibodeau

Sr. Program Manager Kollmorgen Corporation

KOLLIMORGEN

Electro-Optical

347 King Street • Northampton, MA 01060 • Tel.:(413) 586-2330 • Fax: (413) 586-1324 • sales@eo.kollmorgen.com



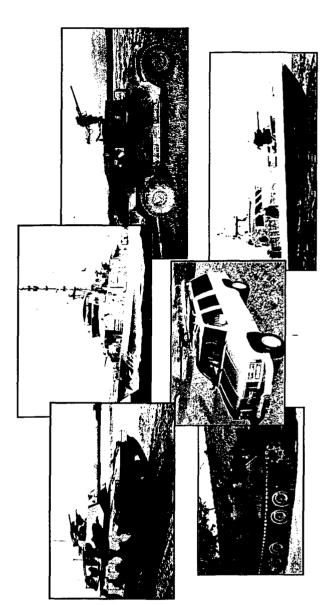
Compact-Lightweight Armored Weapon Station

target engagement

for Wheel/Track

Vehicles and

Marine Craft









ार**ामग**्रा**ारल**ञ्जा Electro-Optical

Kollmorgen Corporation

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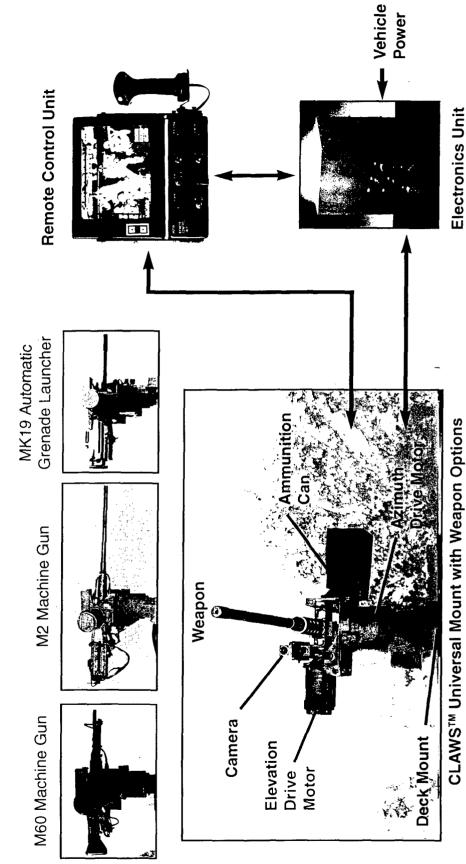
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WEAPON CONTROL SYSTEMS

CONTROL STSTEMS CLAWS

System Overview



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KOLLMORGEN

Electro-Optical

WEAPON CONTROL SYSTEMS



System Features

- 2-Axis Universal Weapon Mount
- Accepts Standard M2, M60 and MK19 Weapons
- Remote Control for improved operation and protection of operator
- PC based digital controls
- I Flat Panel Display with Graphics Overlay
- Handgrip EL/AZ and Firing Trigger
- Firing Modes
- Remote
- Remote Stabilized (optional)



เ**∢o)ศศ**M(o)ถ¢ศฑ∖ Electro-Optical

WEAPON CONTROL SYSTEMS



Specifications

System

- Electronic Drive
- Pointing Accuracy
- Television
- Fire Control
- Power

0.1° to 45° / sec 60° / sec² acceleration

< 1 milliradian

High Resolution CCD Camera

Resolution > 470 horizontal lines RS170

Electronic Reticle with Ballistic Look Up Tables

- 24 VDC 40 Amps/Peak
- -20 Amps/Running
 - —5 Amps/In Idle

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KOJAMOR(C)S

Electro-Optical

WEAPON CONTROL SYSTEMS

Specifications

Mount

■ Control

Train

Mechanical Interface Weapon to Mount

Mount to Vehicle Interface (for "stiff" mounting) with electrical

Security/Safety

Ready Ammo (# Rounds)

. M60 MK19

Ammo Reload

-15° to +45° Elevation

Continuous 360° rotation

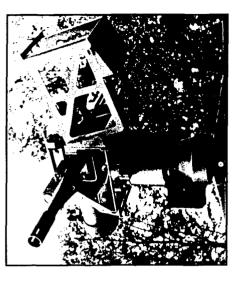
"Standard" Cradle

Bolt down adapter

IAW MIL-STD 454 penetrator

100 250 64 (with dunnage removed)

< 2 minutes



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KOLLMORGEN **Electro-Optical**

WEAPON CONTROL SYSTEMS



Specifications

Sizes & Weights

■ Gun Mount

Size

635mm (25.0") height

970mm (38.2") swing radius for M2 weapon 523mm (20.6") swing radius for MK19 weapon

521mm (20.5") swing radius for M60 weapon 67Kg (150 pounds) less weapon and ammo

Weight

Electronics Unit

363 mm x 267 mm x 273 mm (approx. 11"x 10"x 14") 12.7Kg (28 pounds) Weight

Size

Remote Control Unit

Size

280mm x 285mm x 76mm (approx. 11"x 14"x 3")

Weight

5Kg (11 pounds)

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KOLLWORGEN

Electro-Optical

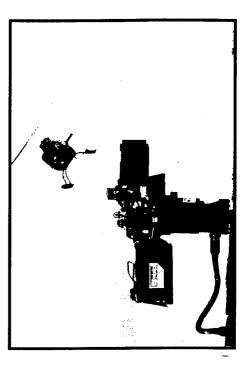
WEAPON CONTROL SYSTEMS



Options

- Stabilization
- Enhanced target engagement
- Sensors
- Infrared Camera
- Low Light Level TV
- Laser Range Finder
- Remote Changing and Safing
- Soft Weapon Mount
- Ammo Counter
- Auto Video Tracking
- Digital Control & Display Variations

- Fire Control Enhancements
- Other Weapons
 7.62 Minigun
- Missiles



KOLLMORGEN Electro-Optical

WEAPON CONTROL SYSTEMS



Summary

- Lightweight, cost effective universal weapon for Armored Vehicles or Naval platforms
- High accuracy remote operation
- Easy installation, minimal vehicle/boat modifications, surface mounted
- Flexible / Modular design allows upgrades and/or tailored configurations



Armaments for the Army of the Future

(NIDA Symposium & Exhibition)

Area Denial Methodologies Robotics for Munitions

24 June 1998

A. Keith Miller

akmille@sandia.gov

William D. Morse

wdmorse@sandia.gov

Sandia National Laboratories

Robots for Munitions Outline

- Mobile, semi-autonomous firepower for Army XXI
- Reconnaissance and surveillance platforms for Army XXI
- Mobile robots for Army After Next
- Small Smart Machines
- Mission scenarios for battlefield surveillance for AAN using robots
- Summary

AKM/9652/061898

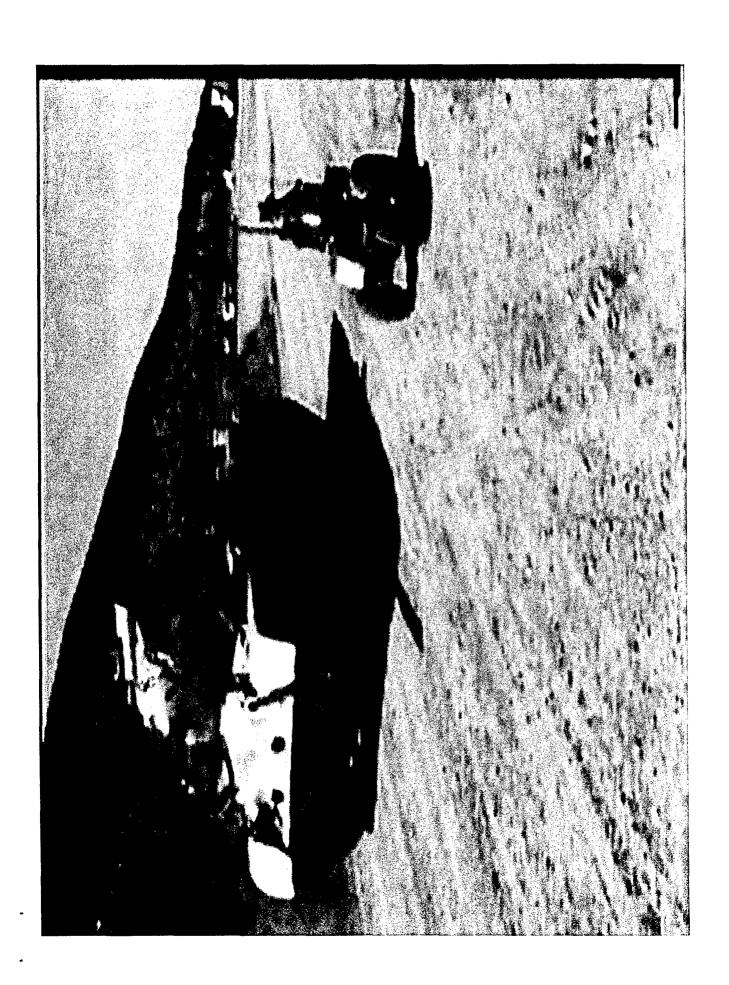
(ran) Sandia National Laboratories

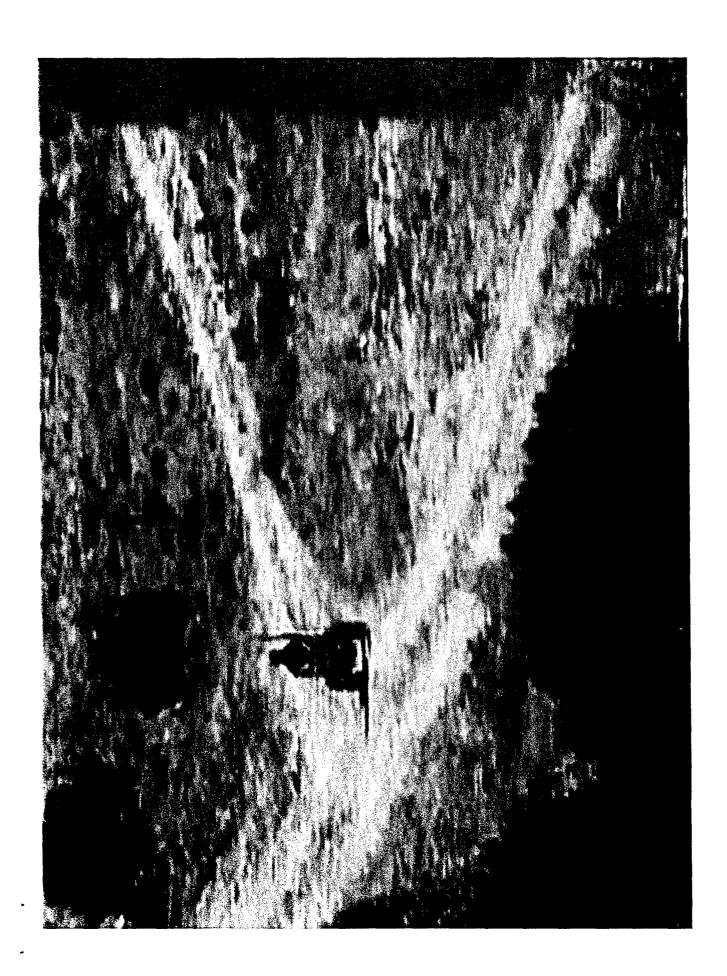
Fire Ant for Army XXI

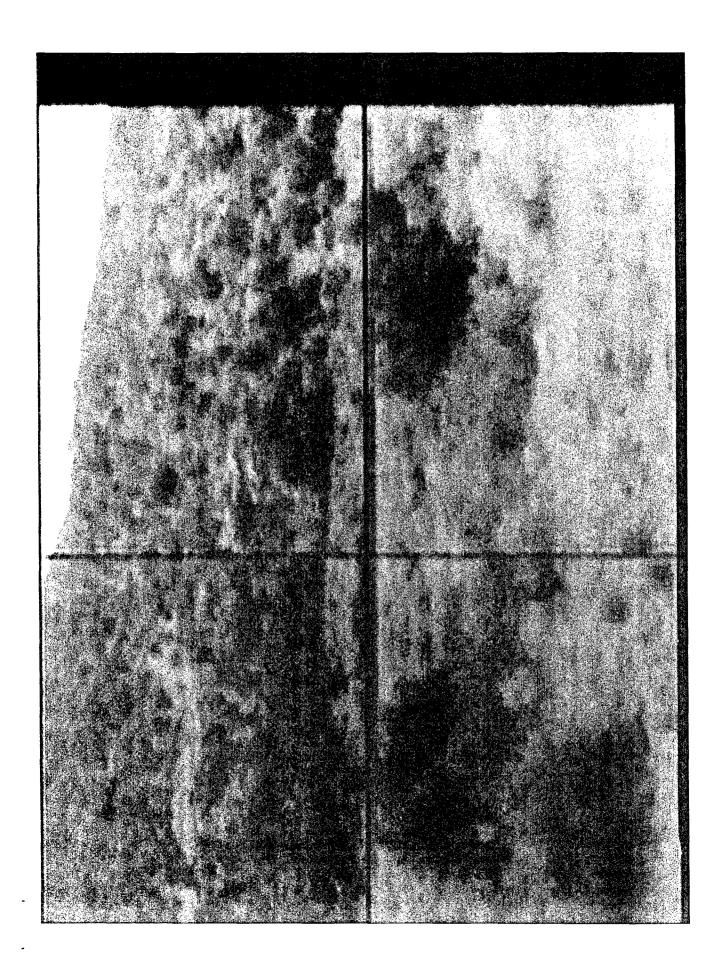
- Based on a reconnaissance and surveillance platform
- Used an Explosively Formed Projectile, but can use other guided weapons
- Mobility teleoperated, autonomous moving target detection, tracking and firing

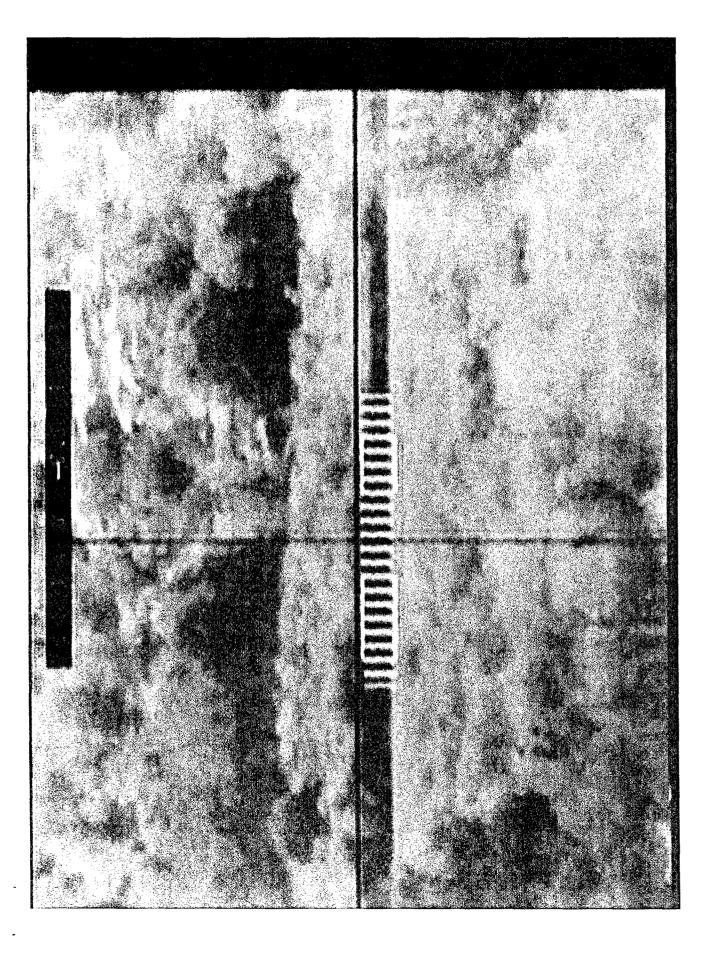


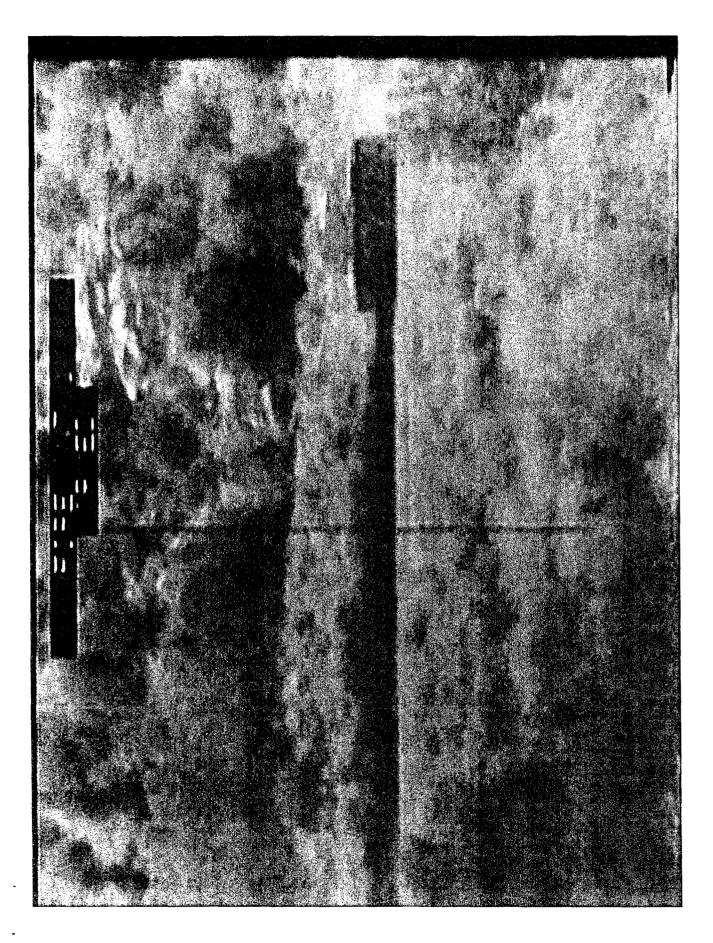


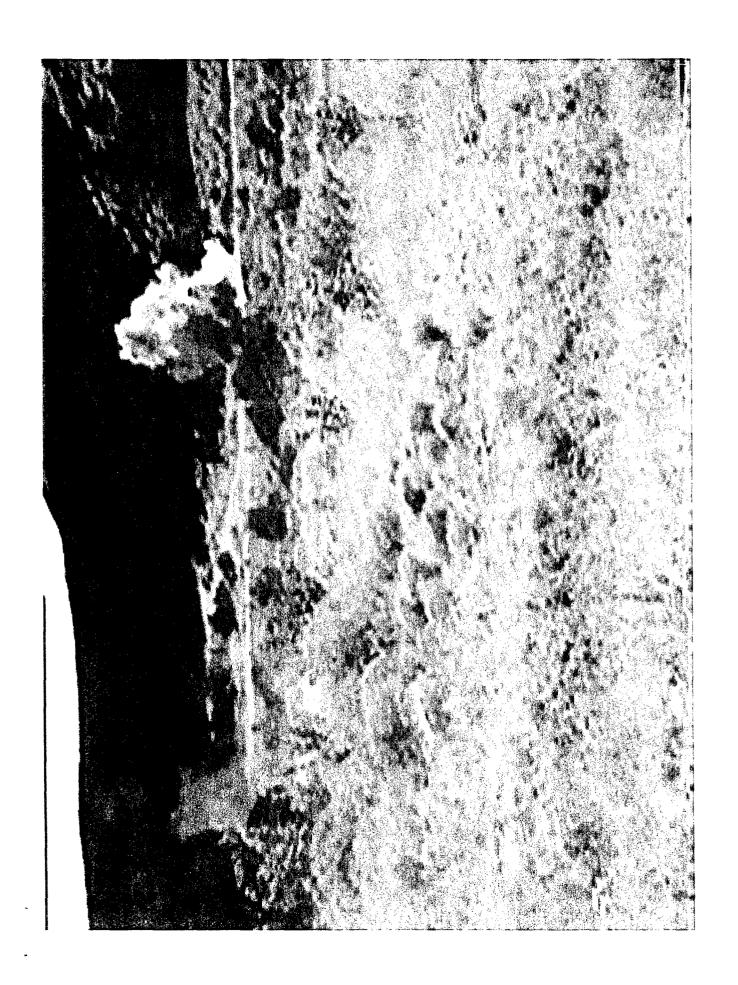










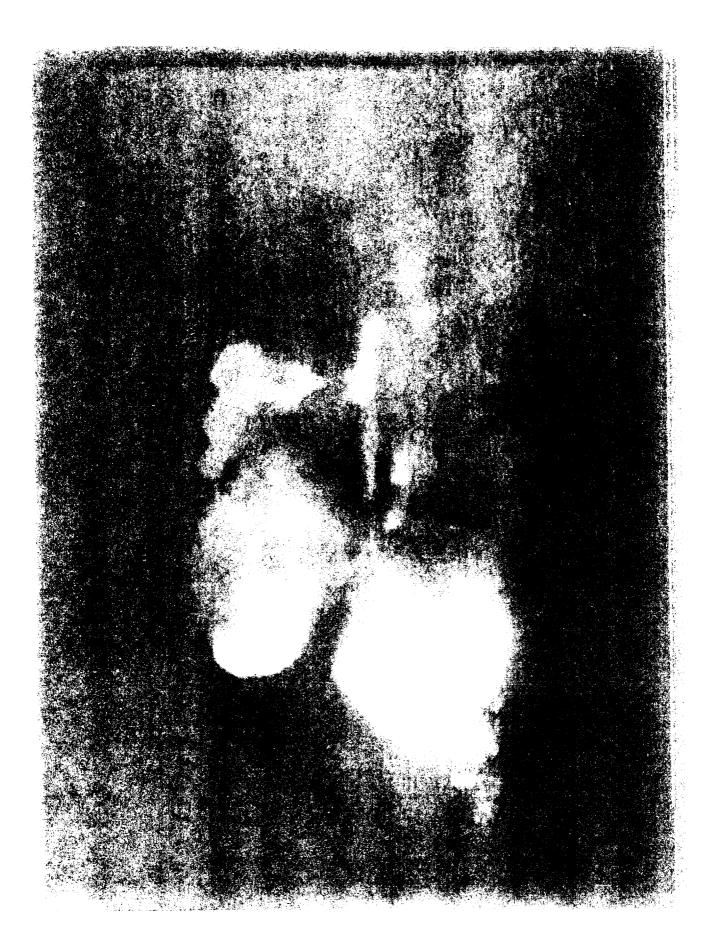


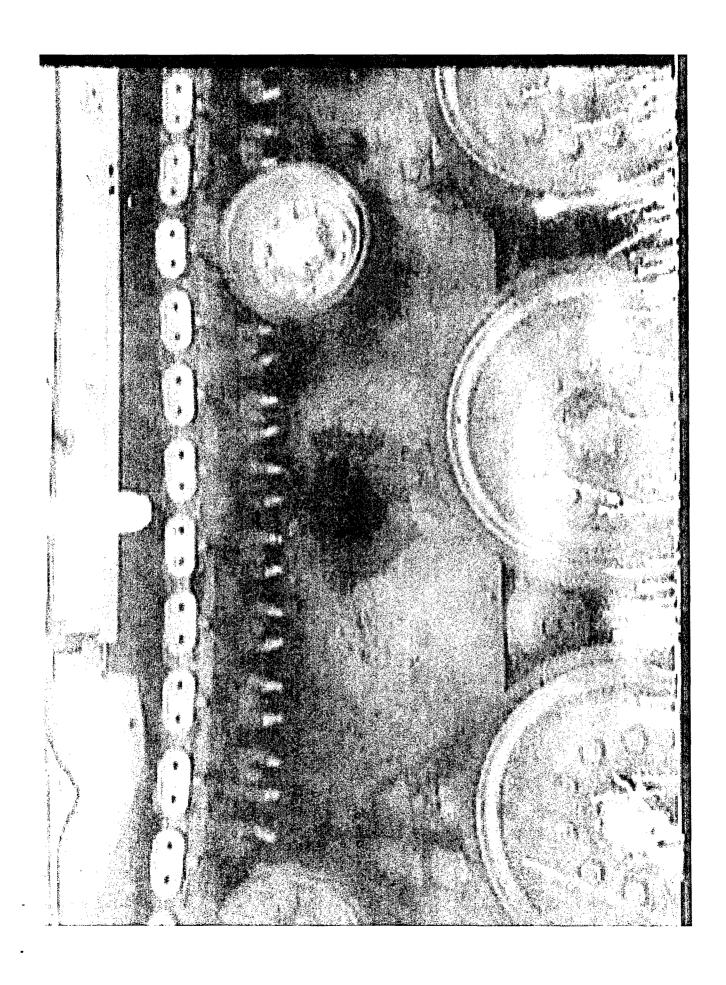














(Sandia National Laboratories

968

Reconnaissance & Surveillance Robots for Army XXI

One operator -- One machine

SARGE

Surveillance & Reconnaissance Ground Equipment

Multi-sensor package military scout vehicle

State-of-the-arm in field portable robotic controllers

Dual LCD monitors display real-time video with graphic overlays

Touch screen/graphical interface

Maintainable/modular design

Carries a variety of Unattended Ground Sensors (UGS)



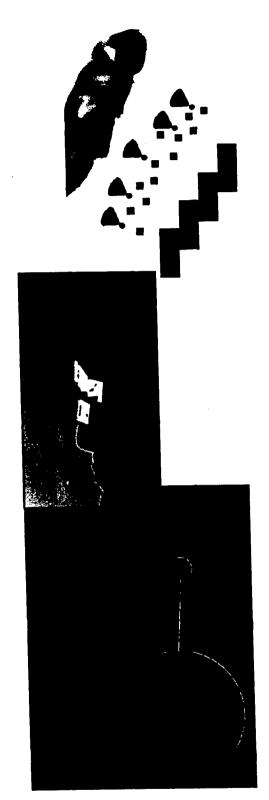


Mobile robots for AAN

One operator -- Many machines Collective Intelligent Systems

Small Smart Machines

may work collaboratively with a large group of similar devices, They may be as large as a "shoebox" in size down to microns. In all cases they must be inexpensive to produce, reliable in These machines may be autonomous or teleoperated. They or as an individual device perhaps performing surveillance. performance, adaptable to changing mission needs, and successful in completing their task.



SSM for PE 6:97 PE

SSM Capabilities



Platform Scale, Intelligence and Numbers

Platform Scale tele-op Platform Intelligence

· As you expand along each axis, the following six - behavior/cooperation technology areas become limiters:

mobility

- communications

sensor systems

navigation

power supply

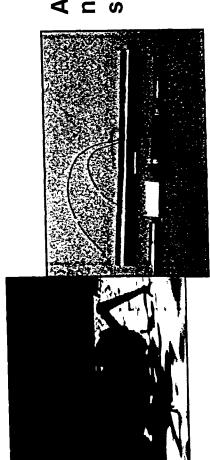
Finally, "operator interface" issues are common to the entire space SSAIS 10/07 RP



Mobility

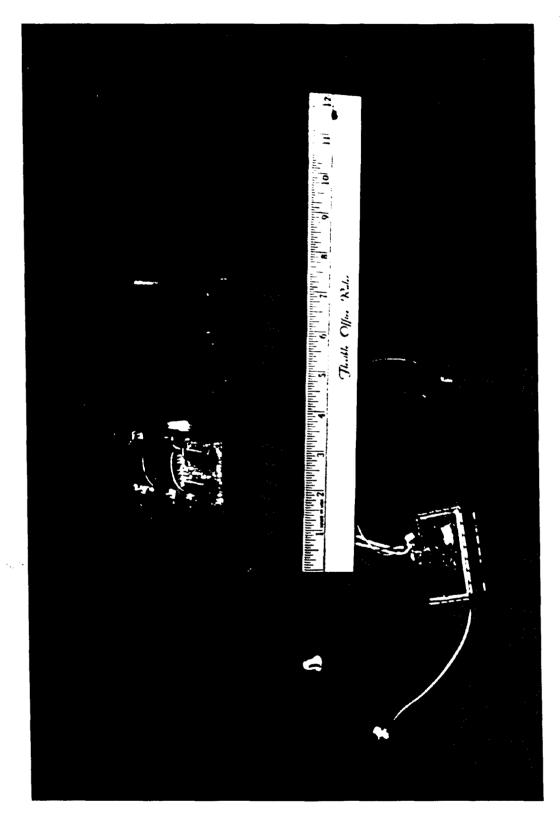
Wheeled / tracked devices work well for larger scale systems



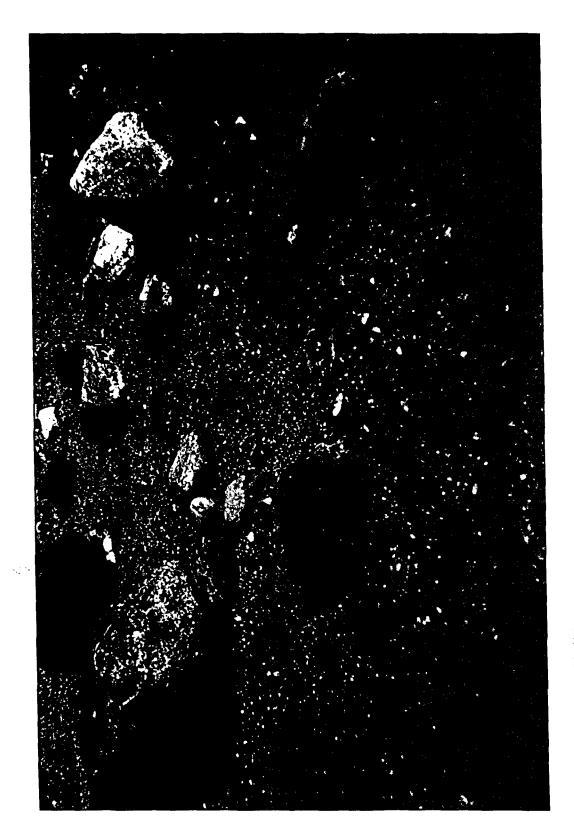


Alternative approaches need to be used for smaller scales

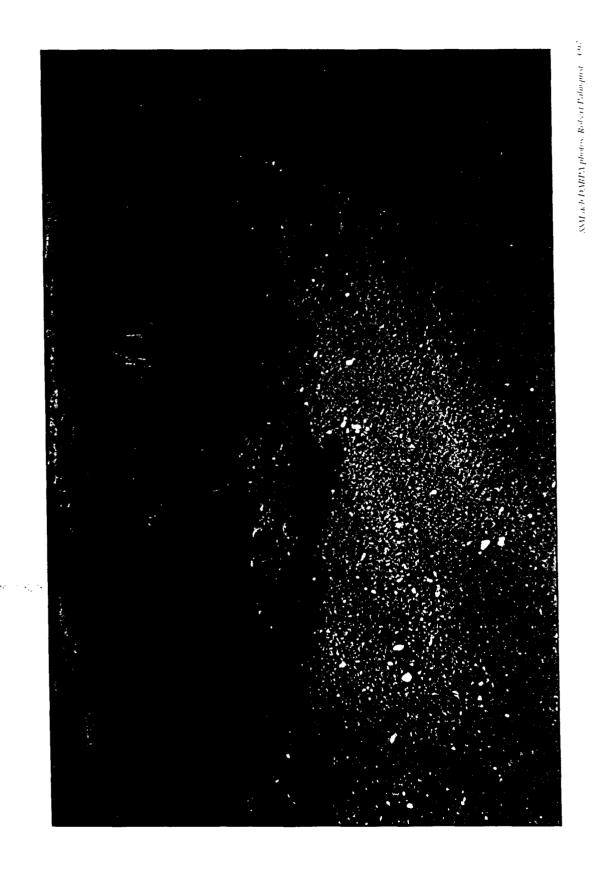




SSM ach DARPA photos, Robert Palmepust (502)

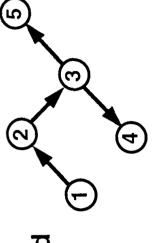


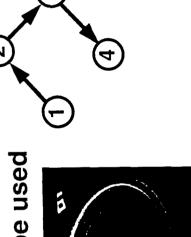
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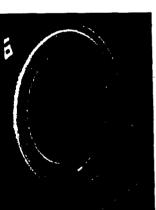


Communications

- adequate for small numbers of Off-the-shelf RF modems are vehicles
- network protocols will be needed As numbers increase, flexible for efficient information flow
- corner cube reflector can be used communications such as Sandia As scale decreases, optical







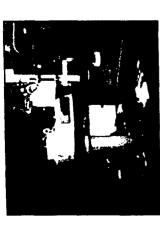
Sandia invests in microsystems programs

and infrastructure

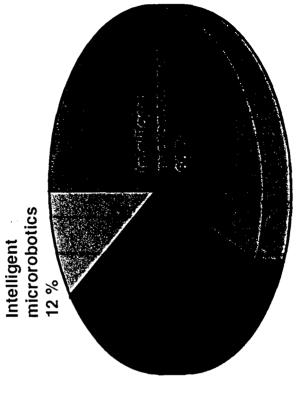
\$17 Million/year microsystem investment



Integrated materials research laboratory



Automated micro assembly laboratory



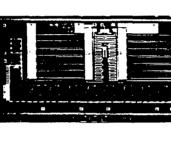
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Sandia's program takes advantage of IC development trends

1000'S OF TRANSISTORS MIXED MODE SENSOR

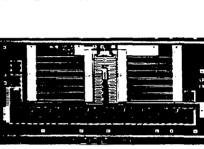
SMART SENSOR 100'S OF TRANSISTORS

INTEGRATED SENSOR 10 TRANSISTORS



DISCRETE SENSOR





1994

1991

1992

SSM och 16 Br. Robert Palm prist 1941 G.

00%

Hardened Deeply Buried Target





Hardened Deeply Buried Target **Tasks**

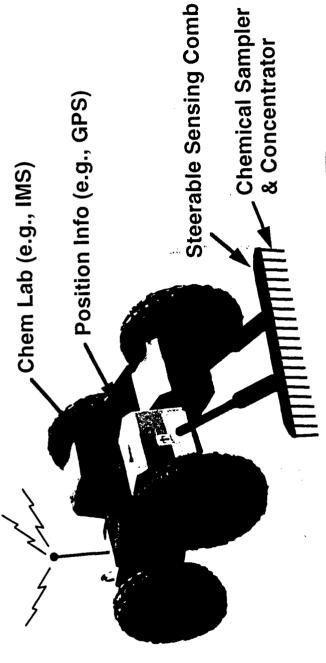
- Observe
- Communicate info out
- Find air ducts
- **Enter air ducts**
- Close air ducts seal
- Find water supply
- Enter/close/contaminate water supply
- Initiate explosion fire
- Find RF signals/beacons
- Find power cables/systems
- Cut power cables/systems
- Penetrate and map facility Determine facility operations
- Find info/com systems
- Inject energy into info/com systems



Th Sandia National Laboratories

Mobile Wide-area Chemical Sensing

- Wide area coverage via
- Fast chemical sensing, plus
- Autonomous vehicles acting on chemical data and EF&T knowledge

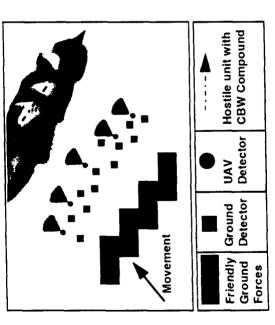


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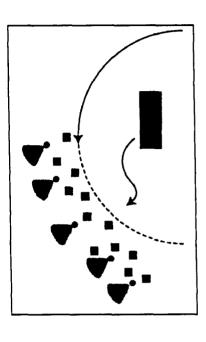
Sandia National Laboratories

Army

Advanced Warning for Chemical and Biological Agents



5 km ahead of the main body, controlled by 1-2 operators Array of mobile detectors

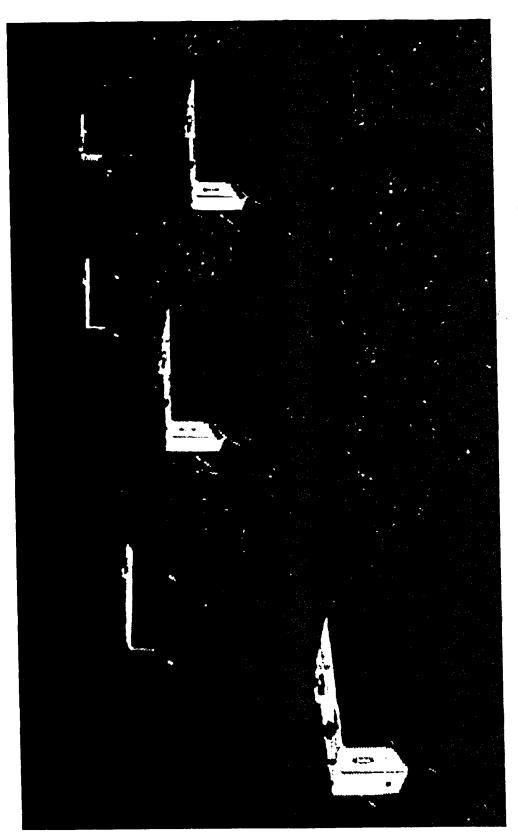


direction change, controlled spacing with troop or wind Automatic realignment and by 1 operator



Sandia National Laboratories





Performing Cooperative Perimeter **SWARM RATLERS** Surveillance

Army



Sandia National Laboratories

Battlefield Surveillance for AAN

Possible Mission Scenarios for

"Wait and Pounce" Concept for UGF Defeat

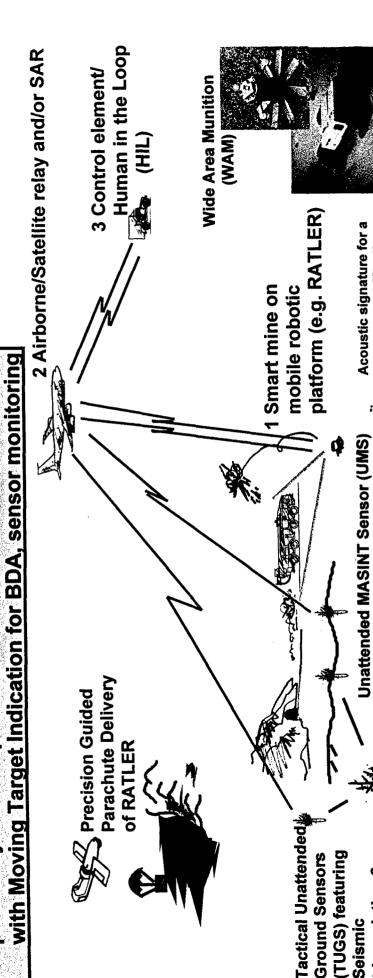
Concept Outline:

TUGS for facility characterization and cue for UMS

Air or Special Ops

Delivered

- UMS for TEL, etc id & cue of robotic munitions platform
- Stealthy, mobile, robotic munitions platform for TEL, etc. kil
 - Integrated, control element for HIL & cross cueing sensors
 - Optional Synthetic Aperture Radar (SAR) platform



SAR tag for location & covert com/data fusion

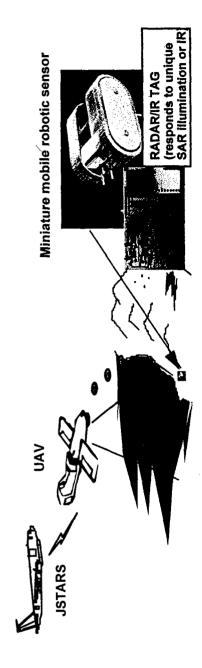
UMS/TUGS/RATLER modified to include

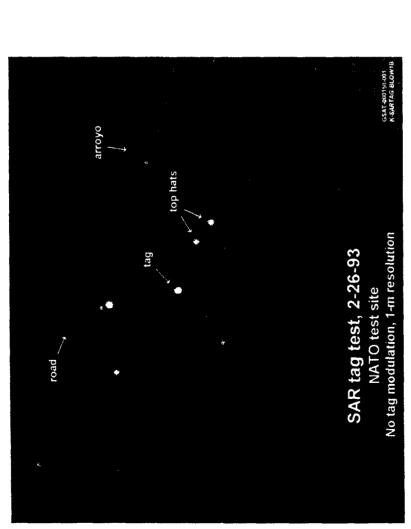
(aka DIA STEEL EAGLE)

triangulation & signature id (shown w/o stealth)

Sandia RATLER

Tag Technology Concepts with mobile UGS







Robotics for the Army-After-Next Warfighter

- The use of mobile robotics to maximize the individual Warfighter's capability:
- Survivability: Early hazard detection of mines, chem/bio ...
- Sustainability: Delivery of emergency medical care, resupply, food ...
- Mobility: Penetration into areas too small or dangerous for humans
- Combat Effectiveness: Weapons Deployment, Surveillance, Reconnaissance



The Precision Delivery of Sensors and Munitions Autonomous Aerial Delivery Vehicle (AADV) for the

June 24, 1998

Dr. Robert J. Correia

Tel: (978)657-2718

rcorreia@systems.textron.com

Textron Systems 201 Lowell Street Wilmington, Massachusetts 01887

Roger Allen Tel: (609)663-2234 roger.allen@sse-inc.com SSE Incorporated 5801 Magnolia Avenue Pennsauken, New Jersey 08109





Agenda



- Leveraging Existing Technologies
- AADV Tactical System Concept
 - Delivery Option Comparison
- Development and Demonstration Plan
- Current Demonstration Configuration
- Near Term Goals (ACT-II)
- Long Range Opportunities/Applications
- Summary





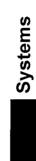
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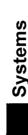
Delivery Need for Munitions and Sensors

- Perceived Requirements -

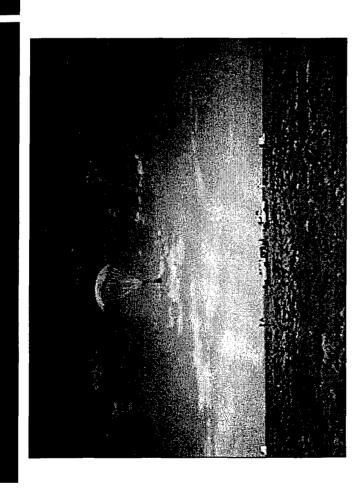
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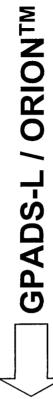
- Depth of delivery
- Order of 30 km envisioned in Intelligent Minefield
- 75 km required in Rapid Force Projection Initiative (RFPI)
- 50 300 km desired for Intelligent Combat Outpost (RAPTOR)
- Precision Location
- Munitions require delivery accuracy to tactical significance (road, choke point,etc.)
- Location accuracy must be compatible with munition/sensor coverage
- Implies 10's of meters for Wide Area Munitions (Hornet)
- Availability to Tactical Commander
- Low Cost

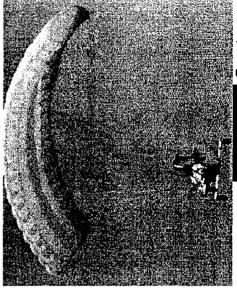




Leverage of Existing Technology







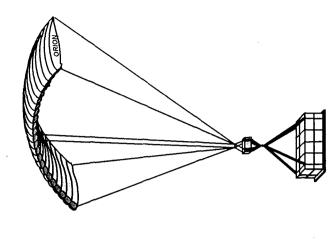
PARAPLANE

Systems

GPADS-L - ORIONTM



- An inexpensive system for the accurate, autonomous standoff delivery of virtually any payload
- COTS System (ORIONTM) developed by SSE
- Passed Technical Qualification in Nov 96
- Used in USMC Hunter Warrior (Feb 97)
- 30+ systems in use
- US Army / US Navy / Australian Army etc

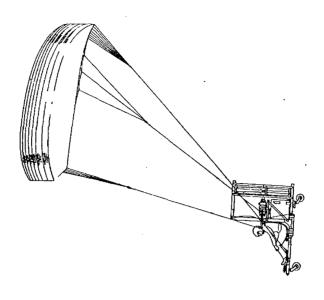


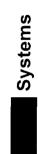




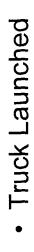
PARAPLANE

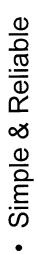
- Powered Parafoil designed by Steve Snyder (founder of SSE) in 1979
- Used by Spec Ops, most use in Recreational Market 10,000 + units in the field
- 800 lb typical suspended weight for 2 seater model



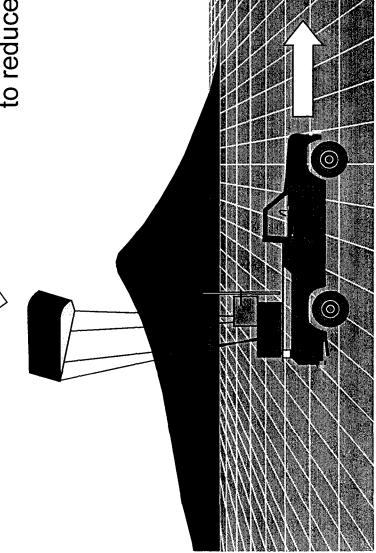


LAUNCHING





 Canopy Pitch control used to reduce launch velocity

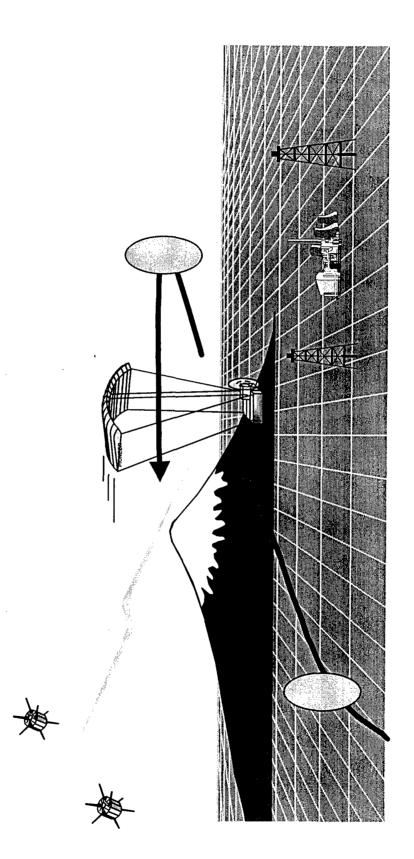


Systems

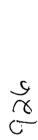


NAVIGATION

Waypoints used to avoid terrain



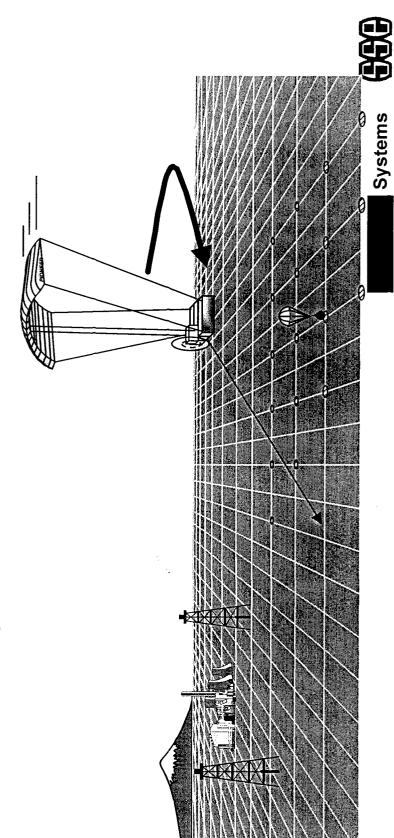




PAYLOAD DEPLOYMENT



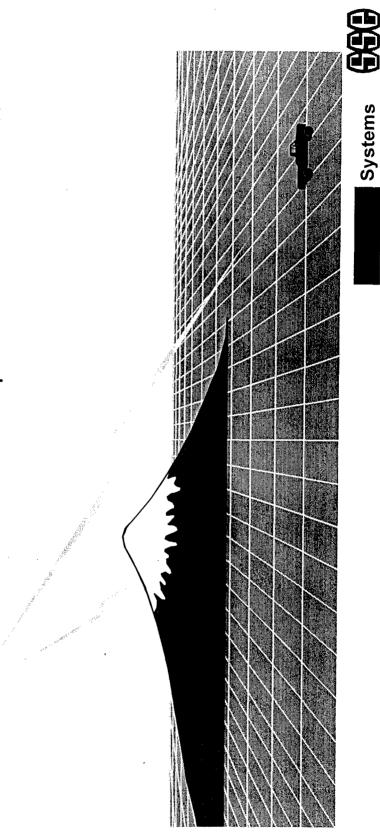
- Use Laser for terrain following
- Altitude Tradeoff of vulnerability Vs accuracy of delivery



RELAY MODE



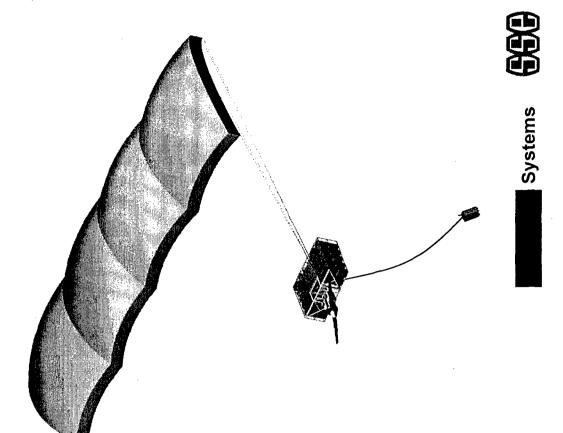
- Acts as relay station
- More than one system redundancy
- Reduced power increased loiter



Systems

Preliminary System Concept (Tactical) Specification

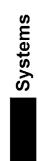
- Payload = 1000 lb of deployable payload
- Velocity = 50 knots
- Range = 50 300 km (fuel / payload trade-off)
- Loiter = 5 hrs 5 Days (fuel / payload / loiter time trade-off)
- Deployment Accuracy = 10-20m CEP
- Max Altitude = 10,000 ft +



NDIA

Delivery Option Comparison

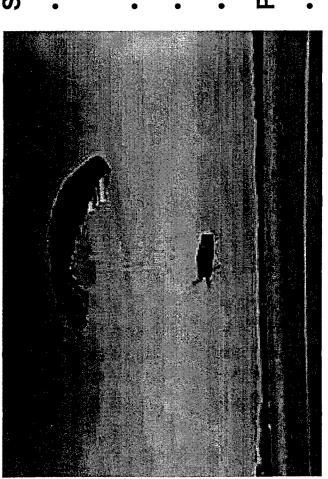
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The speciments are supposed to the state of	Deployment	Manpower	and Production	Emplacement	Brigade
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Hand Emplaced			Green	Green	Green
Helo	Yellow		Yellow	Yellow	Yellow
MLRS	Yellow	Green		The state of the s	Yellow
ATACMS	Green	Green			
Tomahawk	Green	Green			
GPADS-L	Yellow	Green	Yellow		
AADV	Green	Green	Yellow	Yellow	Green
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Current Demonstration Configuration

Test Vehicle (IRAD)



Specification

- Payload = 1000 lb deployable payload in "saddlebag" dispensers
- 110 hp 2-cycle/4-cylinder motor
- 72" Prop
- Radio Controlled Flight

Performance Goals

- Velocity = 40 knots
- Range = 3-5 km
- Max Altitude = 1,000 ft +



Near Term Goals

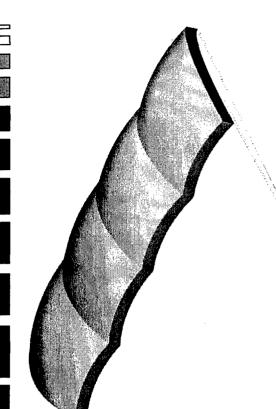
(ACT- II Plan)

Specification

- Payload = 1000 lb of deployable payload
- 120 hp 2-cycle/4-cylinder EFI motor
- Autonomous Controlled Flight with Manuel Override

Performance Goals

- Velocity = 50 knots
- Range = 20-30 km
- Max Altitude = 2,500 ft -5,000 ft
- Loiter time = 2 hrs
- Delivery accuracy = 20m CEP









Long Range Opportunities / Applications

AADV is a general purpose Aerial Delivery Relay and/or Surveillance Vehicle

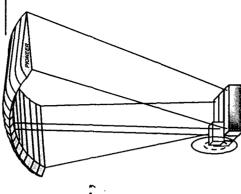
- Munitions
- Hornet, Raptor
- Anti-Personnel Landmine Alternatives (APL-A)
- Sensors
- Air Deliverable Acoustic Sensor (ADAS)
- Damocles ATR Sensor Suite
- Robotic Vehicle(s)





AADV SYSTEM - SUMMARY

- Systems Integration of "Off-the Shelf" Equipment
- Inexpensive, Autonomous, Stand-off Delivery System That Can Be Organic to the Tactical Commander
- Payload Dispensing Needs Evaluation of Deployment Accuracy Capability
- Growth Potential to Multiple Launch Platforms (e.g., Truck, Trailer, Ship, Air or Other)



Systems

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ems (EEE)





Low Cost Sensor Technology for Future Targeting Systems

John S. Eicke U.S. Army Research Laboratory

John Eicke, 301-394-2620





fire support elements with indigenous It is likely that the sensor technology community can provide the future Army low cost, high performance, targeting sensors.

John Eicke, 301-394-2620







- What are the targets & what are their characteristics?
- What sensors are available?
- How can those sensors be emplaced?
- How can those sensors be employed?

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What Are Targets

- **Ground Vehicles**
- Tanks, APC's, Trucks,
- **Aircraft**
- Helicopters, UAV's, fast movers
- **Personnel**
- Moving, Talking, Other activities
- Weapon Firings
- Artillery, Missiles, Mortars
- **Battle Damage**
- **Explosions, Burning**



What Do We Want To Know?



- Target location
- Target track of moving targets
- Target classification
- Target identification
- Target condition

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What Can We Detect?



- Acoustic Emissions
- Seismic Signatures
- Magnetic Signatures
- Visible Signatures
- IR Signatures
- **RF Emissions**
- Chemical Emissions

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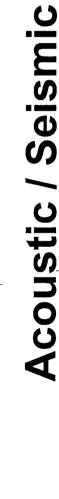
Technical Barriers



- Low cost sensors
- Sensor fusion
- Communications
- Packaging in munitions
- Power Sources

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Sensors are:

- Passive
- Low Cost
- Non-Line of sight
- 360 degree coverage

Shortcomings

- Greatly affected by atmospheric conditions
- Relatively short range

Signal processing is advancing rapidly

- Generic processors & algorithms
- Specific algorithms for battlefield sensors

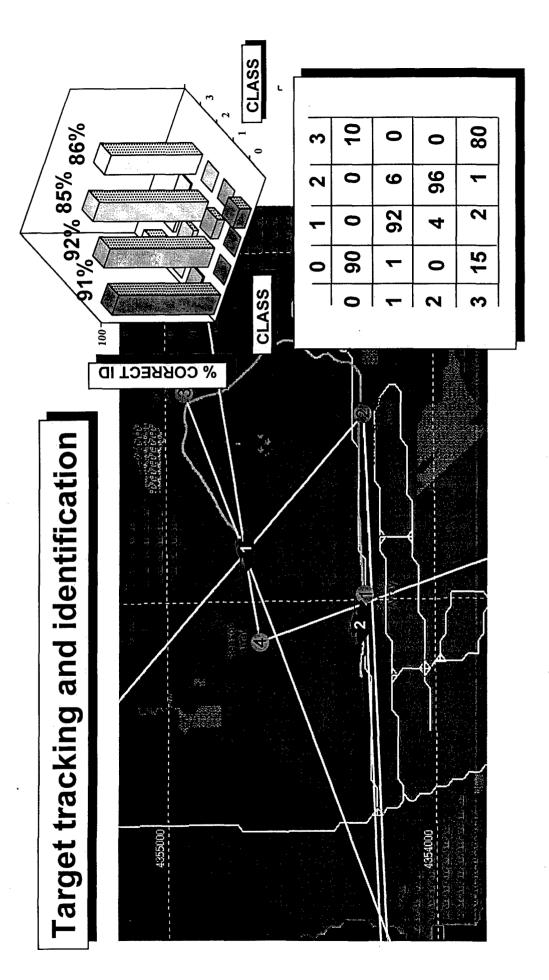
Acoustic arrays can provide:

- LOB to target
- Target classification / identification



Acoustic Vehicle Detection





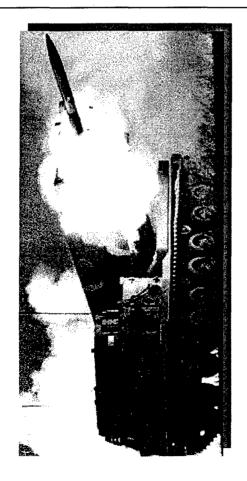
John Eicke, 301-394-2620

Elcke, 301-394-26

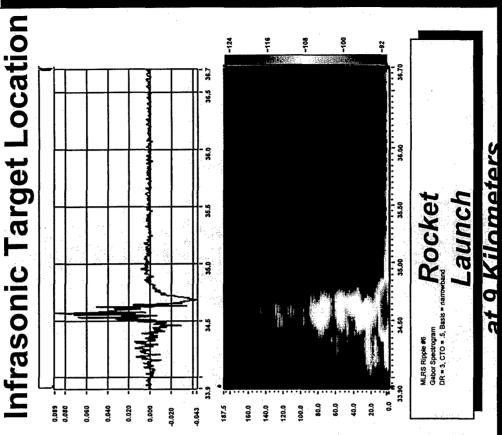




TACoustic Missile Launch Detection ARMY RESEARCH LABORATORY



passive, detection and location Infrasonic detection of missile provides a low cost, accurate, launches and artillery fire capability



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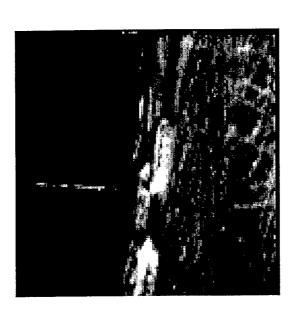


Visible / IR



Sensors are:

- Passive
- High resolution
- Well suited to target identification
- Shortcomings
- Relatively high cost
- Affected by atmospheric conditions
- Relatively short range
- Signal processing is advancing
- ATR
- Image stabilization
- Imaging sensors can provide:
- LOB to target
- Target classification / identification



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Magnetic



Sensors are:

- Passive
- Very Low Cost
- Non-Line of sight
- 360 degree coverage

Shortcomings

- Very short range
- Affected by any magnetic material
- Immature for battlefield use
- Magnetic sensors make good companions to other sensors to reduce false alarms
- Magnetics may be useful for detecting personnel at short range



RF Sensors



· Sensors are:

- Passive or active
- Very Low Cost
- Somewhat Non-Line of sight
- 360 degree coverage

Shortcomings

- Short range
- Wide range of interfering sources
- Immature for battlefield use
- Active RF tripwire sensors are proven technology (prox fusing) but need to adapted to ground use
 - information about aircraft and some ground Passive RF detection can provide useful

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Chemical



Sensors are:

- Passive
- Non-Line of sight
- Potentially very small



Relatively short range

Sandia's "Lab on a Chip"

- Greatly affected by atmospheric conditions
- Immature for battlefield use
- Several programs are focused on small, modest performance detectors
- Chemical sensors can also provide vital clues for **BDA**

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Sensor Fusion



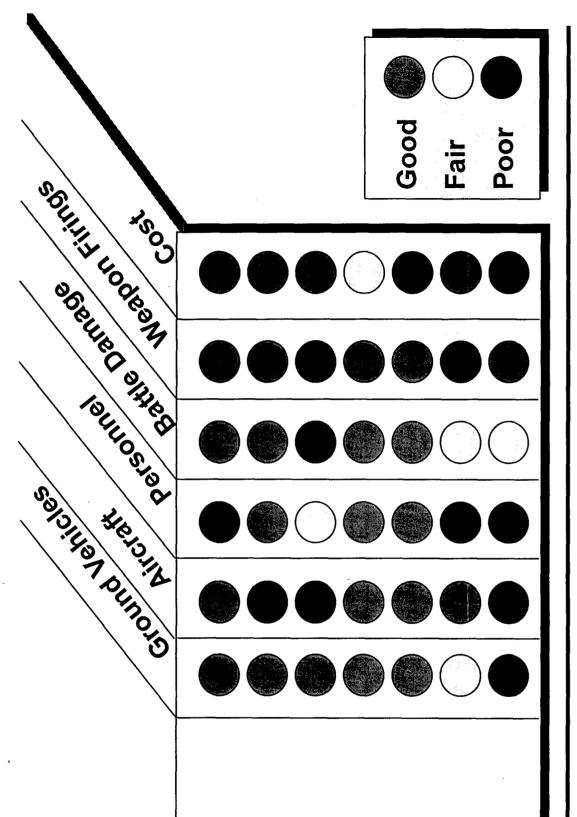
- Sensor fusion is the key to real world performance
- Multiple sensors inputs, each with modest information content, can be fused to provide a more accurate understanding of the target
- Multi-domain sensors provide highly orthogonal views of a target
- Some work is going on in low level sensor fusion

ground like a tank, smells like a tank, and is made of If it looks like a tank, sounds like a tank, shakes the steel like a tank, - it might just be tank.



Sensor - Application Summary





Magnetic

Visible

Acoustic

Seismic

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Chemical

R

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Sensor Emplacement



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Practicality practicality practicality and practicality of the practical pra				
e d	Hand emplaced	Air Dropped	Artillery Delivered	

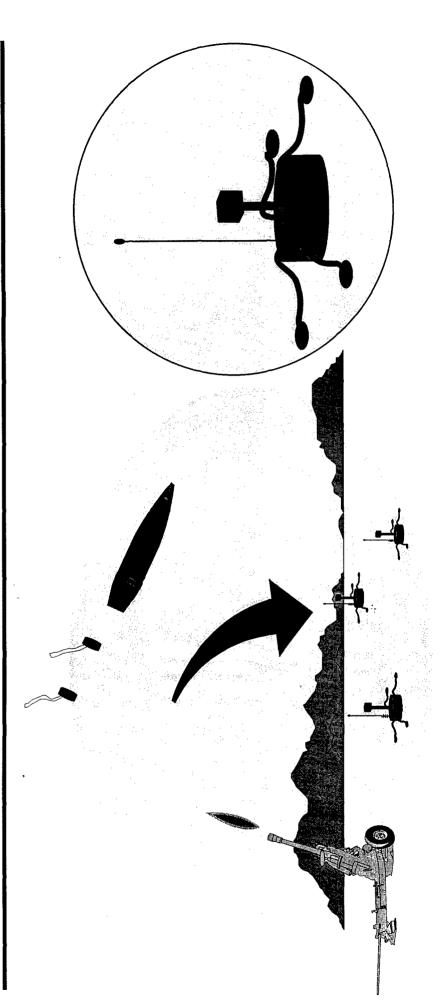
Poor (

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Artillery Delivered Sensor Concept ARMY RESEARCH LABORATORY





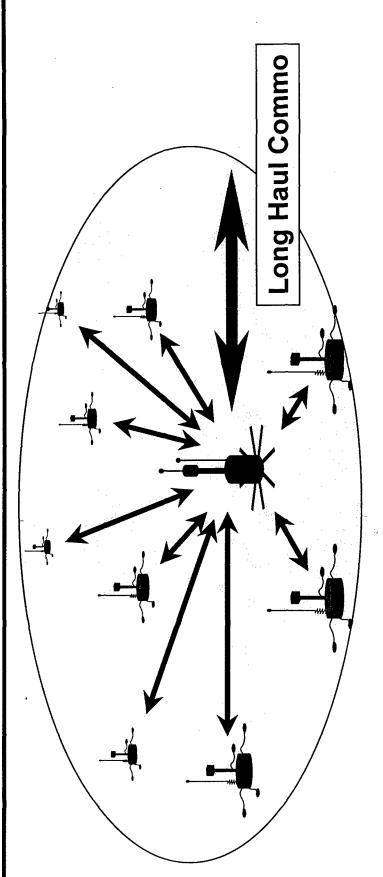
Sensors: Acoustic, seismic, magnetic, chemical imager Commo: Local network, Long haul link to shooter Life: 2-30 hours

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Sensor Network Operation





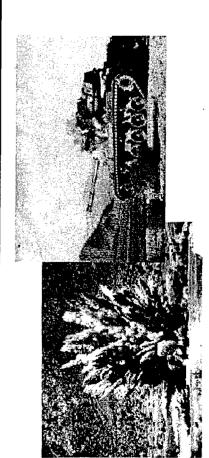
Gateway fuses sensor inputs & controls sensor nodes. Gateway provides long haul communications. Sensor nodes communicate with a gateway.

John Eicke, 301-394-2620



Targets





Battle Damage





Aircraft

Personnel



John Eicke, 301-394-2620







- Indigenous target location, tracking, & identification capabilities are feasible for the field artillery
- Such a sensor network can also play a vital role in an overall area denial system
- sensor fusion, communications and power sources Technology advances in the areas of sensors, are key to overall system success
- There are a number of ongoing programs which are advancing key technology elements

PRESENTATION FOR THE ARMY OF THE FUTURE SYMPOSIUM JUNE 24, 1998

TOPIC

DETECTION AND IMAGING REMOTE PERSONNEL

Presented by

John H.McQuiddy and Russell Thomas MCQ Associates, Inc. 1551 Forbes Street Fredericksburg, VA 22405 (540)373-2374

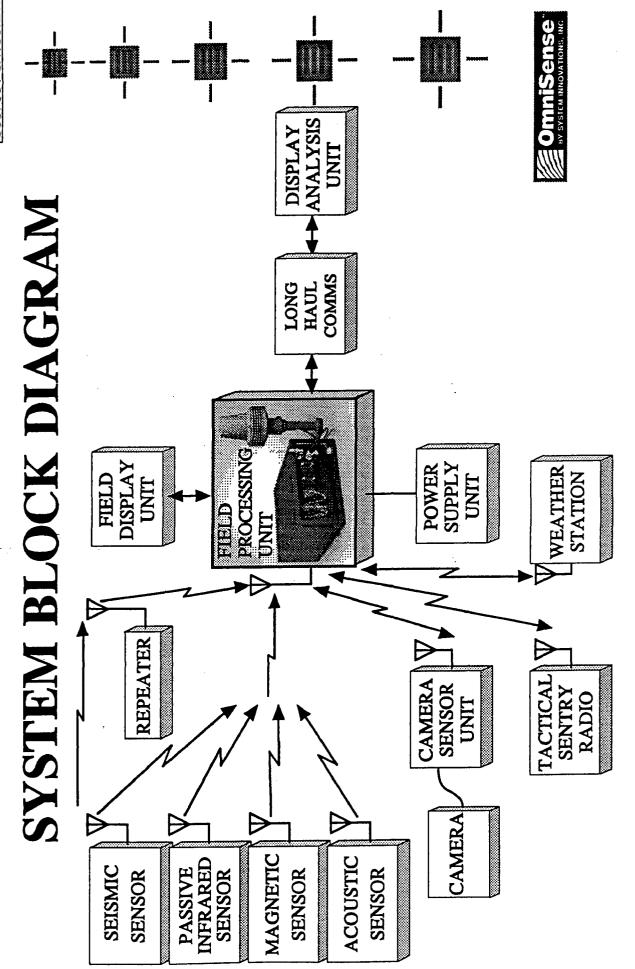
PRESENTATION OUTLINE

- Presentation of Technology Developed for PICATINNEY ARSENAL Area Denial Tech Base Program under George Lutz and Paul Kisatsky
- Discussion of Intelligent Sensors and Sensor Fusion to Detect Personnel
- Discussion of Advanced Digital Imaging Sensor to Verify Target Identity and Location
- Technology Demonstration Provided to show Concept for Remote Personnel Detection and Technology Maturity

REMOTE INTELLIGENT SENSING

- MCQ has developed an Intelligent Remote Sensor System called OmniSense®
- The system concept is designed to reduce false alarms and improve the probability of detection.
- Detection of people or vehicles is done automatically with programmable alarm criteria.
- and processed to initiate imagery sensors for identifying the target. Passive IR, Magnetic, Seismic and Acoustic sensors can be fused
- Communications Architecture allows easy wireless installation with two way control and data.
- User friendly displays automatically alert the operator when activity occurs.

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SENSOR UNITS

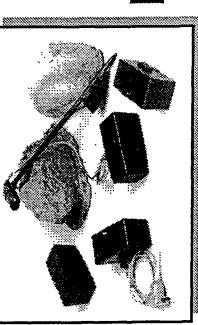
Target • Improved Sensors for Better Probability of Detection Detection



Provides Automatic Threshold Adjustment, Target Classification Advanced • **Processing** Long Life • Designed for Battery Operation with Long Endurance

Communications Using VHF Burst Transmissions Which Are Difficult Low •

Detection Which Are D. Probability to Detect



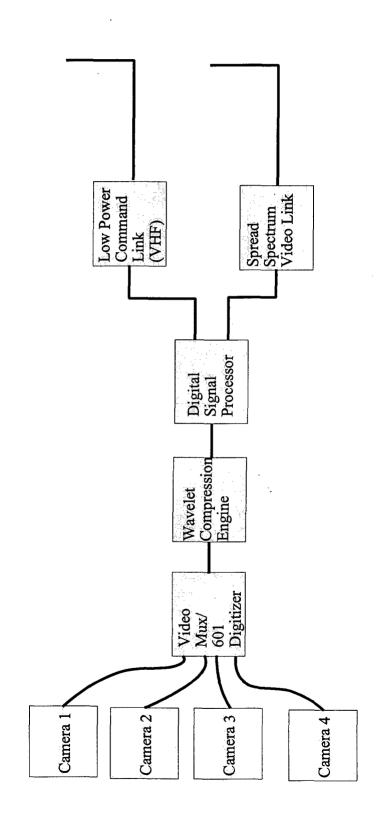


ADVANCED DIGITAL IMAGING SENSORS

- Designed for Remote Sensor Applications
- Low Power Consumption for Long Life
- · Wireless RF Data Links for Easy Installation
- Small Size and Weight
- Sensor Activated Imagery
- · Incorporates Advanced Technology to meet Remote Application Requirements
- Digital Imagery (File Transmission vs TV Transmission) Designed for Computer Display and Storage
- Multiple Camera Multiplexing (Selectable Fields of View or 360 Degree Electronic Scanning)
- Advanced Compression Built into the Sensor Electronics
- Spread Spectrum Communications Built into the Sensor Electronics
- DSP Image Processing and Imagery Control Built into the Sensor Electronics

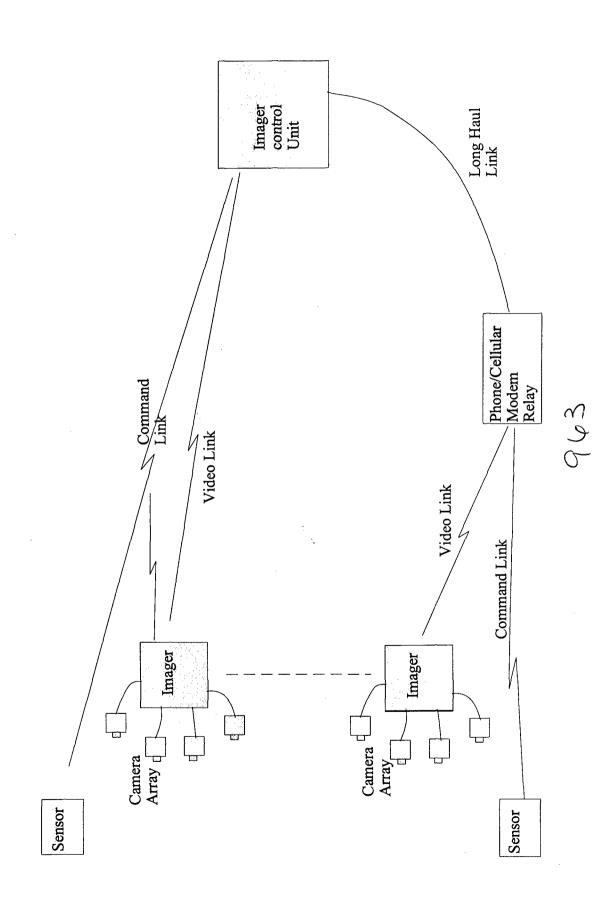
Imager Block Diagram

VHF Control Version



(C) (C)

OmniWatch Block Diagram



USER FRIENDLY DISPLAY

- Automated Activity Monitoring and Operator Alertment
- Integrated Sensor Alarm Programming Control; Imagery Display; Response Activation; Electronic Pan/Tilt/Zoom; Data Storage
- Night Vision Options Include Low Cost IR Flash and More Expensive Uncooled IR Imagers.
- Designed to Accommodate many Detection Zones to locate detected targets and show them on a Map Based Display.
- Imagery Provides Man in the Loop Target Identification and Reponse Discrimination.

APPLICATION SCENARIOS

- Easily Installed in Scenarios with Woods, Clearing, along Paths or Roads, covering Airfields, etc.
- Small Easily Hand Carried Components Buried and Camouflaged to Avoid Detection.
- Effective for Personnel or Vehicle Detection.
- Long Haul Comms Link Alternatives Integrated into System (Terrestrial, Satellite, Telecom)
- Large Scale Networking Available due to Comms Digital Packet Architecture (Compatible with the Internet, LANS, etc.)

TRCHNOLOGYDEMONSTRATION

- Automated Personnel Detection
- Specific Target Area Image Response Using Sensor Alarm Processing
- RF Link Comms with no Wiring
- Battery Operation (with Long Life)
- Single Images or Continuous Imagery
- Compression Rate/Framing Rate Control
- · Operator Display and Control
- Data Storage and Retrieval

CONCLUSIONS

- Intelligent Remote Sensors and Digital Imagery Sensors Provide A Robust Personnel Detection Capability
- Target Location and Identification
- Operator "Man in the Loop" Response Discrimination
- The Technology is Mature and will Continue to Improve
- Picatinney Tech Base Developments of Enhanced Sensors, Data Processing and Displays are Underway
- Low Power Miniature Cameras and Electronics make Field Installation Possible.

Unmanned Aerial Vehicles (UAVs)

Airborne Area Denial System (AADS)

Gene H. McCall Waits L May

June 24, 1998

Background References

- Defense Airborne Reconnaissance Office
- UAV Annual Report
- USAF Scientific Advisory Board
- UAV Combat Operations
- Joint Vision 2010
- Army TRADOC News Service
- Defense for Acquisition and Technology, Fort Belvoir, Remarks by Jacques S. Gansler, Under Secretary of VA, May 19, 1998

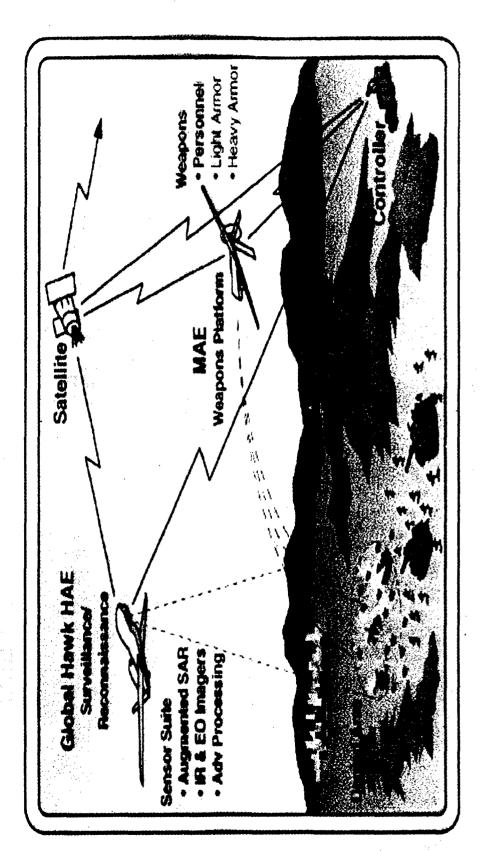
Excerpts From Dr. Gansler, USD(A&T)

- Modernization goals (two of five)
- situation awareness and information assurance an integrated C4ISR infrastructure; enhanced are the critical elements ---
- deploy--in sufficient quantities--long range, allweapons. In many cases, they will be capable of in-flight re-targeting from remote sensors. - in the "strike" area, we must develop and weather, low-cost, precise and "brilliant"

Extracts From TRADOC News Service

- Information exchange built on a digital communications framework will allow the new (heavy) division to cover about three times the area on the battlefield as today's division.
- commanders to move faster and concentrate their fires Speed of communications will allow maneuver more efficiently.
- (with) better visibility over the battlefield, you don't have to worry about that other direction any more. Now, (the commander) can focus his energy in one direction.

UAV Airborne Area Denial System (AADS)



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Characteristics of Existing Platforms

- HAE (Global Hawk)
- altitude 65,000 ft
- speed 345 kt
- endurance > 40 hrs.
- C2 links UHF/MilSATCOM, Ku/SATACOM, X/LOS, UHF/ LOS
- MAE (Predator)
- altitude 25,000 ft
- speed 65 to 115 kt
- endurance >20 hrs.
- C2 links Ku/SATCOM, UHF/MilSATCOM, Trojan Spirit II

HAE Sensors

Synthetic Aperture Radar (SAR)

- All-weather

- 200 km slant range

- 1 m resolution in search, 30 cm in spot

- 1900 spots per sortie

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MAE Weapon Bus

- Flies above ground fire
- Control by LOS or SATCOM
- Payload 450 lb. (PREDATOR)
- 40 second freefall
- 1.4 km range without glide

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Some Advantages of AADS

- No emplaced weapons
- No weapon expenditure except against enemy with no warning
- weapons match target
- Real time observation and weapon deployment
- continuous adverse weather surveillance
- Reduced logistics requirements for maneuver element
- No indication to enemy of location of denied area
- Denied area can be moved quickly
- can be based on global knowledge of enemy
- No safe path through area
- · Can pursue maneuvering enemy
- Simulator training and exercise

Some Disadvantages of AADS

- Unit commander does not "own" all assets
- Depends on integrated information system
- Depends on new concepts of force deployment and protection
- May not be adequate in all terrain
- Current platforms expensive
- Significant initial cost

System Characteristics to Resolve

- Latency
- Number of areas covered by a single HAE
- Controller requirements
- Number of MAEs (weapon buses)
- Optimum weapon number per weapon bus
- Accuracy required
- Weapon mix
- C2 architecture (can affect DARO architecture)
- Sensor characteristics

maneuver denial) and under appropriate concept of operations should be An R&D program to address these characteristics for various roles (e,g, initiated immediately.

Component Characteristics to Determine

Weapon(s) design

• Fuzing options

• Guidance

Aerodynamics

• Platform loading and release

Sensor performance

Conclusions and Recommendation

- A concept is suggested as an interim capability that relies on current technology; a CONOPS and technology integration effort.
- interim capability which also serves as a tool to develop CONOPS and identify integration problems
- develops a follow-on mission optimized capability consistent with Suggest a parallel "look ahead" five component program which Joint Vision 2010:
- Operational concepts consistent with Army XXI
- Sensor development
- Command and control
- Munitions
- Platforms

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